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# MANUAL OF GAS IN ATTACK AND DEFENSE

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# MANUAL OF GAS

IN

# ATTACK AND DEFENSE

BY

MAJOR WILLIAM KIRBY, Inf., R. C.

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# Abbreviations.

| | |
|---|---|
| Bde. G. O. | Brigade Gas Officer. |
| B. G. O. | Battalion Gas Officer. |
| Cl. | Chlorine. |
| CO. | Carbon Monoxide. |
| C. O. | Commanding Officer. |
| D. A. D. O. S. | Deputy Assistant Director of Ordnance Service. |
| D. G. O. | Divisional Gas Officer. |
| D. Mk. III. | "D" Class, Mark 3 (sub-class) Field Telephone |
| H. Q. | Headquarters. |
| Hyho. | Sodium Thiosulphate. |
| N. C. O. | Non-commissioned Officer. |
| O. C. | Officer Commanding. |
| P. H. | Phenol Hexamine. |
| S. A. A. | Small Arms Ammunition. |
| S. B. R. | Small Box Respirator. |

# CHAPTER I.

## Schedule For Training Enlisted Men.

### PART I.—SEVEN WEEKS' TRAINING.

---

Schedule for Training of Enlisted Men.

(For guidance of battalion anti-gas officers.)

1. Seven weeks' training. Two separate hours per week.

a. **Introduction.** Methods of attack. Effects of gas. Seriousness of this form of warfare.

b. (Issue of respirators, roughly according to size.)
**Protection.** S. B. R. Description. Method of working. Inspection.

c. Inspection of S. B. R. (Small Box Respirator).
Visit to Lachrymatory. Chamber for fitting.

d. Drills.
Breathing. Necessity for holding breath.
Exercises in holding breath.
Respirators.
Adjustment by numbers.
Clearing masks.
Smelling for gas.
Removal of masks.

e. Drills (continued).
Exercises in holding breath.
Adjustment by numbers, and without.
Cleaning eyepieces.
Speed drill.

f. Drills (continued).
Exercises in holding breath.
Speed drill and tests.
Giving and passing on orders.
March and short double time march in respirators.

g. **Drills** (continued).
Exercises in holding breath } ½ hour.
Speed in adjustment }
**Lecture.** Gas Alert. (Wind Dangerous.) Measures taken. ½ hour.

h. **Lecture.** Gas shells. Giving alarms, etc.

i. **Drill for gas shells.**
Holding breath.
Adjustment from slung position.
Gas shell demonstration.

j. **Drill.** Revision of Inspection.
Standard tests.
6 seconds.
7 seconds.
Bombing, Physical drill, Bayonet work, etc., in S. B. R's.

k. **Lecture.**
Duties of Company Gas N. C. O. in trench.
First Aid. 45 min.
Protected dugouts.
**Practical** — Revision of drill. 15 min.

l. **Practical** — Clearing trenches and dugouts.
Use of fans and fires.

m. **Visit to chlorine chamber at gas school for:**
a. Examination in standard tests.
b. Passing through chlorine.

n. **Gas cloud and gas shell demonstration at gas school.**

## FIRST LECTURE ON GAS.

### 2. ANTI-GAS MEASURES.

One of the forms of attack you will certainly meet with when you go to the front, is the attack by means of POISON GAS. The first use of gas in modern warfare was in an attack on April 22, 1915, by the Germans at Ypres, on a sector where the French and Canadian forces met. The surprise was complete and the number of casualties enormous. The Allies first used gas on September 25th, 1915, at Loos. Since then the new weapon has been constantly used.

Now, attacks by gas differ from all other forms of attack in that you as soldiers are unable to protect yourselves except by the use of the respirator issued to you. You cannot take cover from gas in the way you can take cover from bullets, splinters, shrapnel, etc. GAS CAN GET AROUND ALL COVER — YOU MUST EVER BE ON THE WATCH.

There are two chief methods of attack:

(1) Gas cloud or mist attack.
(2) Gas shell attack.

**The Gas Cloud Attack.**— Gases used — chiefly Chlorine and Phosgene — ASPHYXIANTS — they act through the lungs, causing death by suffocation. Used because they are:

(a) Heavy — three or four times as heavy as air.
(b) Easily turned into liquids.
(c) Really poisonous.

These gases are liquified by cold and pressure and placed in metal cylinders weighing over 1 cwt. The cylinders are taken up to the front line trenches and placed in special emplacements under the fire step. (See sketch, Par. 3.) When the wind is favorable for an attack (steady — at 5 to 8 m. p. h.) the gas is liberated by turning the stop-cock of the cylinders. The gas being heavy, it is carried by the wind, close to the ground, towards the troops to be attacked, remaining in the bottom of the trenches, dugouts, etc., for several days if it is not cleared.

A definite warning is therefore given to the troops to be attacked, by the direction of the wind — therefore the necessity for wind observation in the trenches.

**C.F. What Steps to be Taken When Wind is Dangerous.**— For a cloud attack a **general alarm** must be given, which will rouse everyone along a wide front.

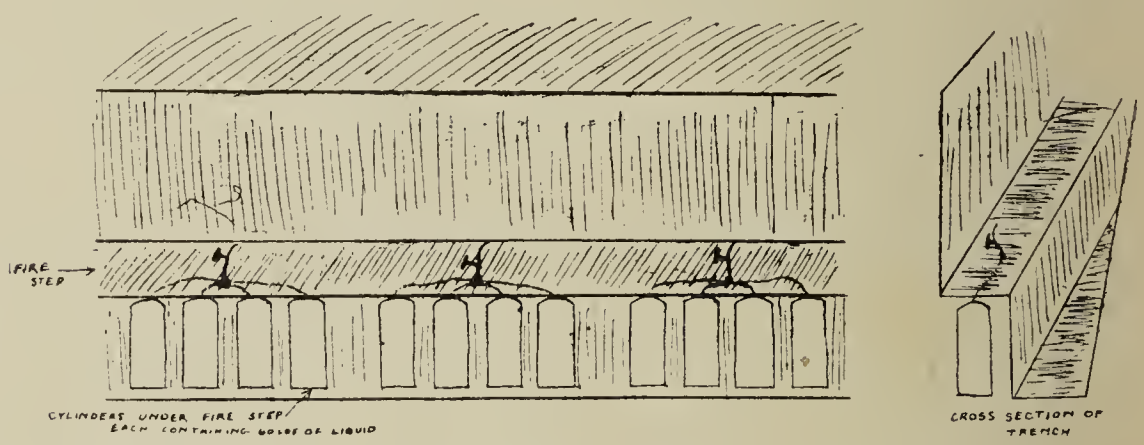
(1) Sentries are posted in every bay with lateral alarms and orderlies within reach. (Explain.)
(2) Strombos Horns. (Explain.)

If proper precautions are taken a surprise attack can very seldom be made.

When attack takes place it can be recognized by (a) Sound of gas escaping from cylinders, (b) Appearance of the cloud, (c) Smell of the gas.

**Gas Shell Attack.**— All areas within five miles of the front line are liable to be attacked by gas shells. These are fired from heavy and light Howitzers and trench mortars or Minenwerfers.

The greater part of the explosive is taken away and replaced by a poisonous liquid, which when the shell bursts, turns into a heavy vapour which hangs about the position for a long time. When fired alone, the shells can be detected (a) by the "wobbly" noise which the shell makes coming through the air, (b) by the small noise on bursting, and (c) by the appearance of a whitish cloud on the bursting of the shell.




Cylinders placed in special places under parapets.

Do not connect up cylinders until attack is to be made.

3,500 cylinders were used on a mile front. Two men to a cylinder.

The reason they are connected up is to send over waves.

Expanded metal work is placed over tanks, and then sand bags. This will not interfere with trench work.

**Warning.**—When old cylinder is disconnected, push red tag over same, with the word "empty" on it. If tags are not available, use marker and mark empty, on outside of cylinder.

Pressure: 170 kilograms to cubic centimeter.

Kilogram equals 4¼ lbs.

Centimeter equals one-third of one inch.

4. A "General" alarm is not wanted, but one that will cover a small area very quickly. (See lecture on gas shells.)

**Protection.**—The S. B. Respirator issued to you is an efficient protection against all poisonous gases used by the enemy. A perfect familiarity with the gas mask and quick application are the only certain means of defence. The necessity of holding the breath directly a gas alarm is given, cannot be overemphasized.

One might mention before going into details about the various gases the importance of knowing your gas mask, how to use it and to have all the confidence in the world in it, because it really is your only life saver against gas attacks.

In the month of January, 1917, four regiments of German Marines were brought up to hold a certain sector of the British front. They had no experience with a gas mask, until they began to realize that the British found this out. Hundreds of Gas Cylinders were brough up by the British, and placed in the usual position, under the fire steps, waiting for the wind to change so that it would be in a dangerous position for the Germans. In the meantime, which was about three days, the Germans drilled and drilled in the use of their own mask, but it was too late, for at the end of three days the British had the wind in the right direction and let forth this rolling cloud of poisonous Chlorine Gas, which went over on the Germans, who had very little training, and the loss of life amounted to nearly 10,000 killed.

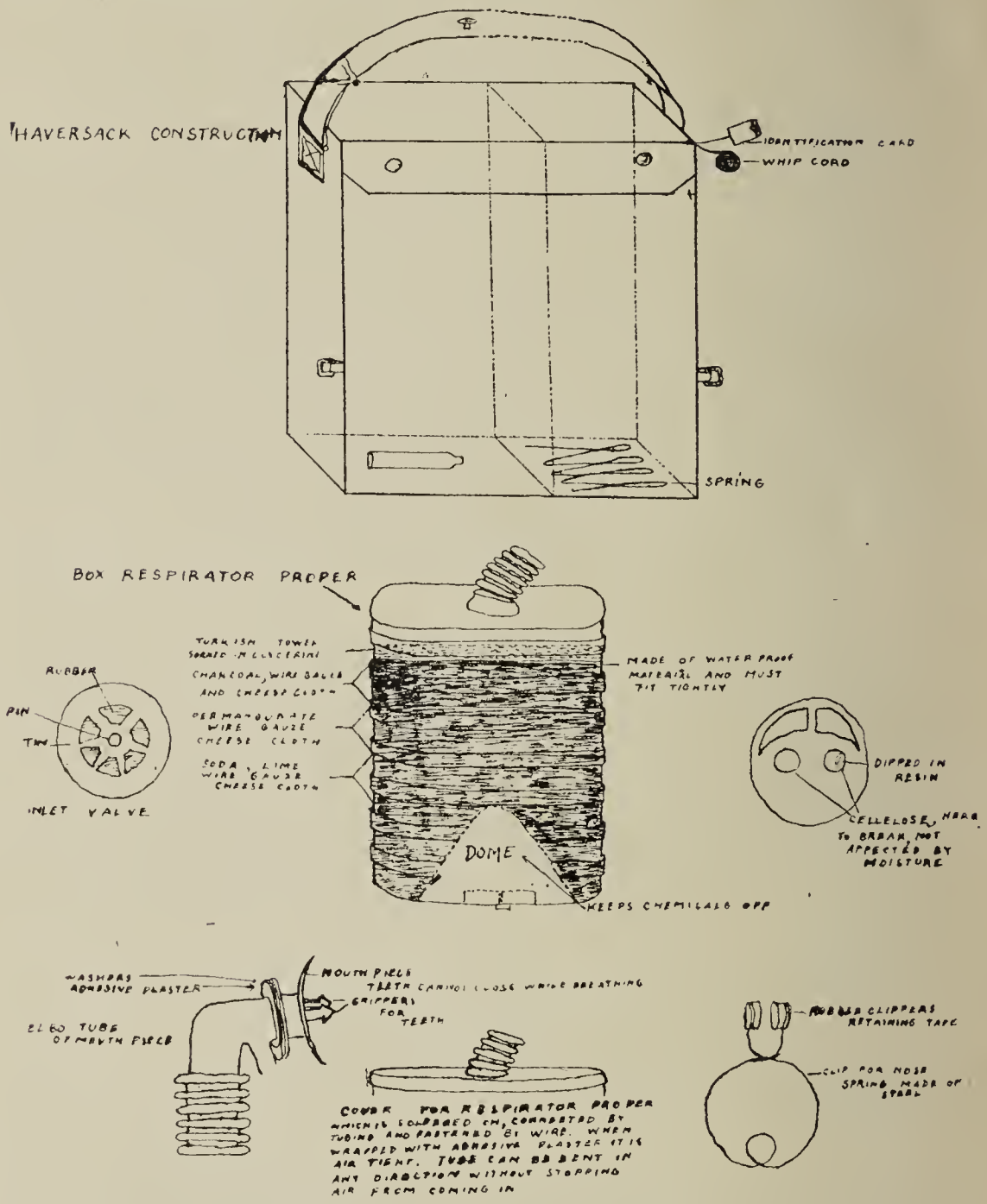
The above only goes to show how one must train and train, in order to secure safety at all times against attack.

## SECOND LECTURE.

### 6. ANTI-GAS MEASURES.

The following notes to be expanded by the battalion Anti-Gas Officers.

Gas alert (or wind dangerous) will be ordered when the wind is in the dangerous quarter, no matter what the strength of the wind.


HAVERSACK CONSTRUCTION
IDENTIFICATION CARD
WHIP CORD
SPRING
BOX RESPIRATOR PROPER
TURKISH TOWEL SOAKED IN GLYCERINE
CHARCOAL, WIRE GAUZE AND CHEESE CLOTH
PERMANGANATE WIRE GAUZE CHEESE CLOTH
SODA, LIME WIRE GAUZE CHEESE CLOTH
MADE OF WATER PROOF MATERIAL AND MUST FIT TIGHTLY
RUBBER
PIN
TIN
INLET VALVE
DIPPED IN RESIN
CELLELOSE, HARD TO BREAK, NOT AFFECTED BY MOISTURE
DOME
KEEPS CHEMICALS OFF
WASHERS ADHESIVE PLASTER
MOUTH PIECE
TEETH CANNOT CLOSE WHILE BREATHING
GRIPPERS FOR TEETH
ELBOW TUBE OF MOUTH PIECE
COVER FOR RESPIRATOR PROPER
WHICH IS SOLDERED ON, CONNECTED BY TUBING AND FASTENED BY WIRE. WHEN WRAPPED WITH ADHESIVE PLASTER IT IS AIR TIGHT. TUBE CAN BE BENT IN ANY DIRECTION WITHOUT STOPPING AIR FROM COMING IN
RUBBER CLIPPERS RETAINING TAPE
CLIP FOR NOSE SPRING MADE OF STEEL

The order "Gas Alert" will be sent out to all units by Corps H.Q. (or, if authority has been so delegated, by Divisional H.Q.), but Brigade H.Q. or Battalion Commanders are empowered to order a "Gas Alert" as a result of wind observations made by Company Gas N.C.O's. forwarded by Company Commanders. Such action will be reported immediately to the next higher formation.

"Gas Alert" will not be taken off without the authority of the Corps Commander, or the Divisional Commander to whom authority has been delegated.

**Wind Reports.**— Every three hours or oftener if the wind is in or approaching a dangerous quarter:

For direction — Wind Vane — describe type, points of compass used.

For strength — Beaufort flag used with the Beaufort scale.

**Type of Wind Report.** (Illustrate)

## BEHAVIOR DURING GAS ALERT.

**Inspection of Box Respirators.**— All box respirators will be carefully inspected and the inspection repeated only daily about one hour before sunset.

**Alert Position for Box Respirators.**— All ranks will carry their box respirators in the alert position. Nothing slung across the chest must interfere with the immediate use of the respirator.

**Sentries, etc.**— All working parties will have a sentry posted to give instant warning of a gas attack.

A sentry will be posted at each Strombos Horn or other alarm device and instructed in its use.

A sentry will be posted to every large dugout and to each group of small dugouts.

A sentry will be posted to each Headquarters, Signal Office and independent body of men.

Arrangements will be made by the officer in charge of the trench for warning the Artillery Observation Post if there is one in the trench.

Commanders of units in billets within eight miles of the front line trenches will organize a system of giving the alarm and rousing all men in cellars or houses.

At night sentries must have at least two men within reach of them so that the alarm can be spread rapidly.

**Sleeping.**— When a gas attack is probable, men in front line trenches will sleep on the fire-step instead of in dug-outs.

Men sleeping in rearward lines or in works where they are allowed to take off their equipment, will sleep with their box respirators on the person.

**Company Gas N.C.O's.**— Company Gas N.C.O's. will report to Company H.Q. in readiness to assist the Company Commander should a gas attack occur.

## 7. AMMONIA CAPSULES.

Medical Officers in units must see that a proper proportion of the ammonia capsules are with stretcher bearers in the front line, in readiness for their immediate use after a gas attack.

## 8. GAS ALARM.

In the event of an enemy gas attack the alarm will at once be given by all means available — by telephone, Strombos Horns, gongs and, if necessary, by orderly. Sentries will warn all ranks in trenches, dug-outs, observation posts or mine-shafts.

All ranks will at once put on their box respirators.

Troops in the front line trenches and elsewhere where the tactical situation requires it, will stand to arms. All ranks in the front lines are forbidden to remain in, or go into, dug-outs or move to a flank or to the rear.

If troops in support or reserve lines of trenches remain in, or into, unprotected dug-outs, they must continue to wear their anti-gas appliances.

**Unnecessary Movement to Cease.**— There must be as little movement and talking as possible.

On the alarm being given, all bodies of troops or transport on the move will halt and all working parties cease work until the gas cloud has passed.

If a relief is going on, units should stand steady as far as possible until the gas cloud has passed.

Supports and parties bringing up ammunition and grenades will only be moved up if the tactical situation demands.

**Protected Shelters.**— The blanket doorways of protected dug-outs, cellars, etc., will be let down and carefully fixed in position.

## 9. ACTION DURING AN ENEMY GAS ATTACK.

Should the gas cloud be unaccompanied by an infantry attack, the signal for gas will be sent and the S. O. S. signal will not be made unless an infantry attack develops.

**Tactical Measures.**— The troops in the front trenches will open a slow rate of rifle fire against the enemy trenches; occasional short bursts should be fired from machine guns to ascertain that these are in working order. All available howitzers should be turned on the enemy's trenches from which the gas is being emitted, or in which the enemy infantry may be concentrating for the assault.

Should an infantry attack develop, the normal procedure of S. O. S. will be carried out.

Troops in the front line must be prepared to bring a cross fire to bear on the enemy attempting to advance against a gassed portion of the line.

**Movement.**— All movement must be reduced to a minimum. There should be as little moving about and talking as possible in the trenches. Men must be made to realize that, with the gas now used by the enemy, the observance of this rule may be essential for their safety.

## 10. ACTION AFTER AN ENEMY GAS ATTACK.

**Removal of Respirators, etc.**— Men in charge of anti-gas fans will use them as soon as the gas cloud has passed, so as to admit of respirators being removed.

Box respirators will not be removed after a gas attack until permission has been given by the Company Commander who will, when possible, ascertain from officers and N.C.O's. who have been trained at a Gas School that it is safe to do so.

**Preparation for a Subsequent Attack.**— So as to be ready for a subsequent gas cloud, all ranks will replace their box respirators in the "Alert" position.

A sharp look-out must be maintained for a repetition of the gas attack as long as the wind continues in the dangerous quarter.

**Clearing of Shelters.**— Dug-outs, cellars, etc., must not be entered before they have been thoroughly ventilated, except by men wearing box respirators. Thorough ventilation, by means of fires or anti-gas fans, is the only sure way of clearing a shelter.

**Movement.**— No man suffering from the effects of gas is to be allowed to walk to the dressing station.

The clearing of trenches and dug-outs must not be carried out by men who have been affected by the gas.

After a gas attack, troops in the front trenches are to be relieved of all fatigue and carrying work for twenty-four hours by sending up working parties from companies in rear.

Horses which have been exposed to the gas should not be worked for twenty-four hours if it can be avoided.

**Cleaning of Arms.**— Rifles and machine guns must be cleaned after a gas attack. Oil cleaning will prevent corrosion for twelve hours, but the first opportunity must be taken to clean all parts in boiling water containing a little soda.

## THIRD LECTURE.

### 11. GAS SHELLS.

These shells contain a small bursting charge and a liquid chemical substance which is converted into vapor and gas when the shell bursts. To have a satisfactory effect a large number must be discharged in a small space. The bursting charge, though not so powerful as that of the ordinary shell, is nevertheless sufficient to produce a considerable exposive effect in addition to the actual gases.

Talk briefly upon:

(1) Nature of Armament.

(2) Description of the various kinds of shells. Poisonous and lachrymatory and their effects.

(3) The tactical use of gas shells.

It is very important that each man should be able to recognize gas shells, be able to give the alarm and put on his protection promptly. The alarm is given either by men shouting "Gas Shells" or using rattles. The following scheme is suggested:

1. A short talk to the men (15 minutes) upon these points:

(a) Up to 5 miles from front line likely to get Gas Shells, they can be recognized by:

(1) Wobbly noise.

(2) Slight detonation on bursting (duds).

(3) Dense white cloud on bursting.

(b) Necessary that all men within 300 feet of bursting shell should get the alarm and put on protection.

(c) By considering (1) The direction of the wind; (2) Their distance from bursting shell.

Men should be able to immediately decide whether to shout "Gas Shells" first, hold breath and then put on protection, or hold breath, put on protection and then shout "Gas Shells."

Rattles can be used, after men, who have them, have completely adjusted their protection. All must be impressed with the complete protection afforded by the S. B. R.

2. After all the men have thoroughly understood the procedure to be adopted, the following practical work should be followed:

(a) Paper bags burst to represent gas shells, at varying distances and directions. Men should either shout "Gas Shells" first or get on protection first according to (c) (1). Repeat when squad is on the move.

(b) Small puff balls (gunpowder, brown paper, fuse) burst and procedure in (2) (a) followed.

(c) By arrangement with the Gas Officer, gas can be liberated as each puff-ball bursts.

3. Repeat (a), (b) and (c) above with the S. B. R's. at the slung position. Squads stationary and moving, men must remember to:

(a) To move out of thick part of cloud.

(b) To keep clear of area being shelled.

(c) To pick up all equipment before moving on.

N. C. O's in charge of squads must move their men out of area shelled and out of cloud as quickly as possible.

## FOURTH LECTURE.

### 12. TYPICAL STANDING ORDERS FOR COMPANY GAS N. C. O'S.

(1) They will assist officers at the inspection of box respirators, helmets and goggles and in making such local repairs as are possible. They will assist in training men in the use of anti-gas appliances.

(2) Under the Company Commander they will have charge of all anti-gas trench stores as follows:

(a) Strombos Horns and other Gas Alarm Devices — Inspect daily and see that sentries posted to them know how they should be used.

(b) Gas-proof Shelters — See that the blanket doorways fit and are kept in good order.

(c) Anti-Gas Fans — See that they are in their proper position and in serviceable condition.

(d) Stores of fuel for clearing shelters — Insure sufficient supply for clearing all dug-outs, to be maintained under company arrangements

(e) Vermorel Sprayers — Maintain in working order and see that supply of solution is available.

(f) Gas Sampling Apparatus — Have charge of the vacuum bulbs and gas-testing tubes. Keep a stock of corked bottles and small tins with well-fitting lids for collecting samples of earth and water after a gas shell attack.

(3) On relief they will assist the Company Commander in taking over all anti-gas trench stores. The Company Gas N. C. O's. should accompany the advance party and take over anti-gas trench stores (by daylight if possible).

(4) They will make wind observations every three hours, or more frequently if the wind is in or nearing a dangerous quarter, and will report any change of wind to the Company Commander.

(5) During a gas cloud attack they will take gas samples by means of the vacuum bulbs and gas-testing tubes.

(6) During or after the attack the N. C. O. must note down in writing as much information regarding the attack as possible.

(7) As soon as possible after the conclusion of a gas shell bombardment, the Gas N. C. O. must fill his bottles and tins and take samples of water, mud or earth, from those parts of the line which are smelling most strongly of shell gases. He should note the position of any blind shells.

(8) As soon as possible after a gas attack, all samples and notes will be handed to the Company Commander for transmission to the Divisional Gas Officer.

**First Aid.**— Talk on the following points:

(1) If a man is gassed or wounded he must on no account be allowed to remove his respirator while the gas is about. Hands to be tied if necessary.

(2) Clothing loosened round neck, chest and waist. Equipment, etc., removed.

(3) Man to be removed to a protected dug-out, or if that is not possible, placed on the top of the parados.

(4) A gassed man must not walk. He must be treated as a stretcher case. REST IS ESSENTIAL.

(5) When gas cloud has been cleared away or the man has reached a protected dug-out, his respirator may be removed.

(6) Vomiting is beneficial.

(7) Ammonia inhalation from Capsules in possession of stretcher bearers often give relief.

(8) No movement and as much rest as possible.

9. Sometimes alcoholic treatment will help.

10. MOST IMPORTANT — Do not use artifical respiration.

**Poisoning By Carbon Monoxide.**— This gas is not used directly in an attack, but causes a large number of deaths.

It poisons the blood. It is much lighter than air.

It cannot be liquified easily.

The respirator is not protection against this gas.

Death by this gas is very pleasant, one simply goes to sleep, with no ill effect.

It is formed when carbon burns, *i. e.*, when there is very little air in a confined place.

When any high explosive explodes in a confined place, such as the entrance to a trench, mine or dug-out, carbon monoxide is formed.

It forms from a back blow from machine-guns, also from artillery that is enclosed or confined.

Men who are engaged in trench work or mines, and have to use high explosives are most subjected to this kind of gas.

Explosion of coal dust forms carbon monoxide.

This set lasts for one-half hour, and one has to be very careful with it or it is liable to go up.

Pressure is about 150 atmospheres.

This is strapped to the body.

Artificial respiration is the only cure.

No action on the heart, but on the blood.

## 13. PROTECTION OF SHELTERS.

**(1) Methods of Protection.**— Protection of dug-outs, cellars, buildings, etc., is given if all entrances are closed by well-fitting doors or by blankets sprayed with hypo solution from a Vermorel sprayer. Practically no gas passes through a wet blanket, and the protection depends on getting a good joint at the sides and bottom of a doorway, so as to stop all draughts. This can be effected by letting the blanket rest on battens, fixed with a slight slope, against the door frame. The blanket should overlap the outer sides and a fold should lie on the ground at the bottom. A pole is fastened to the blanket, which allows the latter to be rolled up on the frame and causes it to fall evenly.

Wherever possible, particularly where there is likely to be movement in and out of the shelter, two blankets fitted in this way but sloping in opposite directions should be provided. There

should be an interval of at least three feet between the two frames, and the larger this vestibule is made, the more efficient is the dug-out. When not in use, the blankets should be rolled up and held so that they can be readily released, and so should be sprayed occasionally with water or a little Vermorel sprayer solution.

If the blankets become stiff from a deposit of chemicals, they should be sprayed with water.

All ranks must be taught how to use gas-proof dug-outs, *e. g.*, how to enter a protected doorway quickly, replacing the blanket immediately, and carrying in as little outside air as possible.

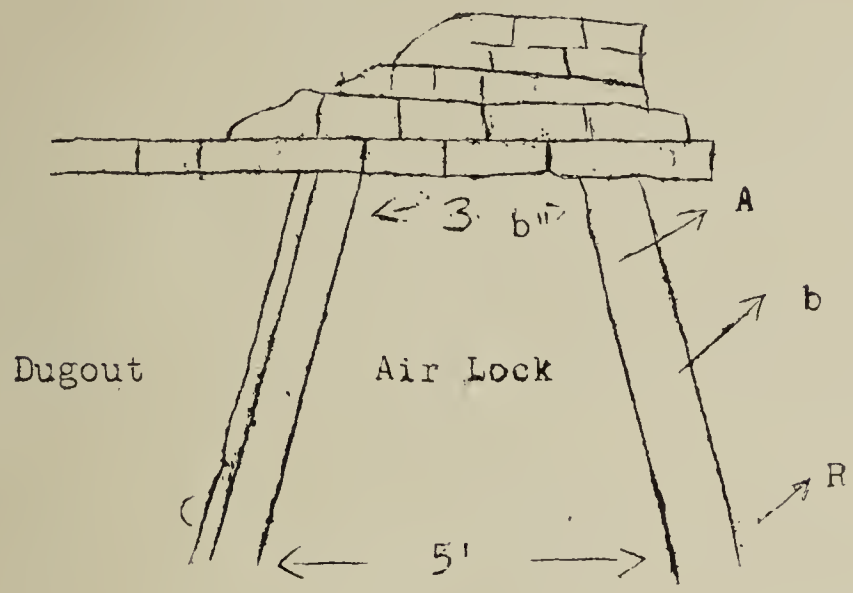
The protection afforded by these means is just as complete against lachrymatory gases as it is against cloud gas and poisonous shell gases.

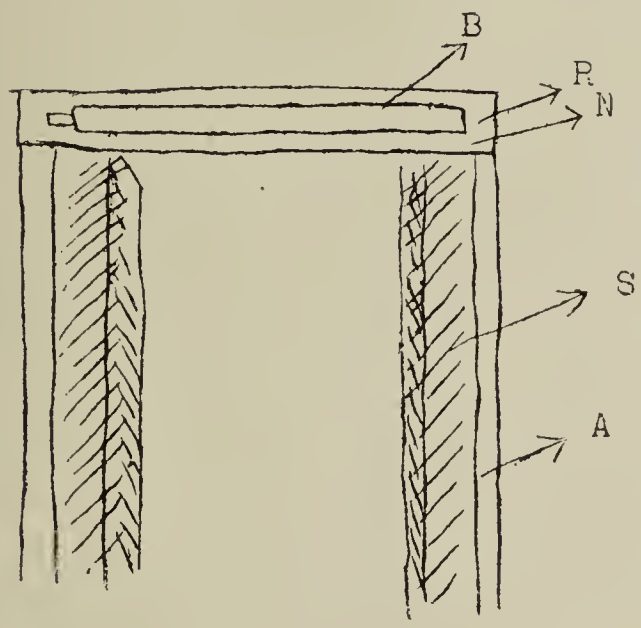
**Shelters Which Should Be Protected.**— The following should always be protected:

Medical aid-posts and advanced dressing stations, Company, Battalion and Brigade Headquarters, Signal Shelters and any other place where work has to be carried out during a gas attack.

In addition to the above, it is desirable to protect all dug-outs, cellars and buildings within the shell area, particularly those of artillery personnel. It should be noted, however, that the protection of dug-outs for troops in the front line of trenches is usually inadvisable on account of the delay involved in getting men out in time of attack. It is desirable to protect stretcher bearers' dug-outs with a view to putting casualties in them.

14. PROTECTED DUGOUTS.



## PART 2.—SIX-DAY COURSE.

### 15. SIX-DAY COURSE IN ANTI-GAS MEASURES.

#### First Day.

8:30– 9:15 A. M. *Introductory.*

1. Methods of gas attack.
2. History of gas attacks and defense.
3. Necessity for careful training.

9:15– 9:30 A. M. *Recess.* Issue of Small Box Respirators.

9:30–10:15 A. M. *The Gas Mask.* (Small Box Respirator.)

1. Description and mechanism (with mask in hand).
2. Inspection.
3. Demonstration of drills.

10:15–11:30 A. M. *Practical.*

1. Visit to Gas House for:
   (a) Smell of chlorine.
   (b) Fitting by passing through lachrymator.
2. Drill in adjustment — by numbers. Practice A. B, F. G.

#### Second Day.

8:30–10:15 A. M. *The Cloud Gas Attack.*

1. Kinds of gas used. Effects.
2. Methods of installing gas in trenches.
3. Three signs of approaching cloud attack. Wind observations. Introductory. (Necessary conditions.)

*Recess.* Exercise in holding breath.

5. Wind dangerous period. Precautions taken.
6. Means of giving alarm for cloud gas.
7. Action to be taken in the trenches during a gas cloud attack and rules to be observed.

10:15–11:30 A. M. *Drills.*

Exercise in holding breath.
Adjustment by the numbers.
Practice D, E, H.
Speed adjustment. (Alternate with adjustment by the numbers.)

**Third Day.**

8:30–10:30 A. M. *Cloud Gas Attack* (continued).

1. Action after a gas attack — clearing of the dugouts and trenches.
2. Protection of arms, ammunition and equipment.

*Recess — Drills.*
Exercise in holding breath.
Speed with accuracy of adjustment.

3. Protected dugouts. Description and use of.
4. Use of smoke in warfare.

10:30–11:30 A. M. *Practical.* Passing through chlorine.

**Fourth Day.**

8:30– 9:10 A. M. Wind observations. Beaufort scale. Wind reports.

9:10– 9:30 A. M. Practical wind reports.

9:30–11:30 A. M. Smoke and gas cloud demonstration in trenches, followed by clearing of trenches and dugouts with fans and fire.

**Fifth Day.**

8:30– 9:45 A. M. *Gas Shells.*

1. Description. Armaments.
2. Kinds of gas used.
3. Tactical uses.
4. Signs of a gas shell attack.
5. Methods of giving the alarm.

Note-books to be handed in.

9:45–11:00 A. M. *Gas Shell Demonstration.*

11:00–11:30 A. M. Route march in respirators.

### Sixth Day.

8:30– 9:00 A. M. *Effect of Gas and Treatment of Gas Cases.*

FIRST AID.

9:00–10:00 A. M. *Organization of Gas Service in Foreign Forces.*
Anti-gas duties with an infantry regiment.
Standing orders.
Duties of Company Gas N.C.O.

10:00–11:00 A. M. *Mutual Instruction in Squads.*

11:00–11:30 A. M. Disinfection of gas appliances. Demonstration and conferences.

## ANTI-GAS MEASURES.

### 16. First Lecture.

**First Use of Gas by Germans, April 22, 1915.**—Gas (Cl) was first used by the Germans on April 22, 1915, in back of Ypres near the junction of the French and Canadian lines. The gas was sent over by the cloud method. This Chlorine Gas causes death by suffocation. It was entirely unexpected, so heavy casualties resulted. There was no protection against it at the time. Since that date the Germans have been using gas with increasing cleverness. The Allies soon caught on and have used it in return.

**First crude protection against gas, used by the Allies.**—As a protection against chlorine gas attacks, the Allies, at first, used to soak their handkerchiefs in water or in their own urine and wrapped it about the nose and mouth. Then it was found that Sodium Thiosulphate (Hypo) would absorb chlorine, so pads soaked in Hypo and tied around the neck by tapes were used.

**Crude methods used.**—Another means of protection against chlorine gas was a bottle with the bottom knocked out and filled with moist earth and cotton. The soldier breathed through this bottle by applying to his lips.

**Second Great Gas Attack—Chlorine-Phosgene. November 19, 1915.**—Realizing the Allies had protection against Cl, on Nov. 19, 1915, the Germans sent over by the cloud method a combination of chlorine and phosgene. The phosgene was not absorbed by Hypo, water or urine. Hence, more adequate protection was needed.

**Gas Shell Attack by Boches July, 1915.**—In July, 1915, the Germans began to put gas in shells. Anyone near a bursting shell became a casualty. In every battle now, gas shells are used.

**Last Great Gas Cloud Attack, Jan. 31, 1917.**—On Jan. 31, 1917, there occurred a cloud gas attack against the French, when casualties occurred twenty miles behind the lines.

**Methods of Gas Attack.**—There are two ways gas may be sent over:

**1. Cloud or Mist:**

Gas in form of liquid is placed in iron cylinders and taken to front line trenches. When wind is favorable the cylinders are opened, the liquid turned into gas, and carried by wind over the enemy's trenches.

**2. Gas Shell:**

Shells are filled with poisonous liquids which turn into poisonous vapor upon bursting of shell.

**Cloud Method Out of Date.**—The cloud method is seldom used now and then only against undisciplined and poorly trained men.

**Gas Shells Used Now.**—Gas shell method now used for nine-tenths of gas attacks in France. Take place every day and every minute. Thirty to forty per cent of shells fired by every gun and battery are gas shells.

**Need for Careful Training.**—Success of these attacks is due to surprise. Hence men must be very carefully trained, always on the alert, and expert in defense against gas attacks.

Men must understand:

1. Shell or cloud gas attacks.
2. Their protection and its mechanism.
3. Quick adjustment of masks.
4. Must hold breath while donning.
5. Must always be on alert and ready to give gas alarm.
6. Must have confidence in protection.

**Reasons for Passing Men Through Gas Chamber.**—For the following reasons men must go through Gas Chamber:

(a) Every Officer, N. C. O. and man must pass through gas before going over seas.

(b) Insures careful adjustment of masks.

(c) Insures careful inspection.

**The Gas Mask.**—The Gas Mask, called Small Box Respirator, is a protection against all gases used by Germans such as Chlorine (affects lungs); Prussic acid (affects nerves); Tear Shells (affects eyes), and "Mustard Oil Gas" (affects skin).

## The Cloud Gas Attack.

**Qualities Desired in Gases Used in Clouds:**

1. Must be heavier than air.
2. Easily liquified.
3. Cheap to manufacture and raw material plentiful.
4. Very poisonous.

**Gases Used in Cloud Method.**— Gases used almost exclusively in Cloud Gas Attacks are **Chlorine** and **Phosgene.**

These two gases are liquified by cold and pressure and put in steel cylinders. The cylinders act exactly like soda water containers.

These cylinders are taken into the front line trenches and put in special emplacements under the parapet, beneath the fire step — four or five in a place.

Number of cylinders needed in attack varies. In one attack 3,500 cylinders were used for one mile front. Three or more successive waves are sent over in one attack to surprise the enemy. Cylinders are covered over with sand bags because (1) they are out of the way and (2) in trench raids for gas scouting, they are hidden from view; (3) sand bags save cylinders from hostile fire.

When aviators or scouts discover such gas present they signal back to artillery G-A-S. If accompanied by infantry attack, artillery is warned in ordinary way.

Usual combination of Chlorine and Phosgene:

Summer, 50 per cent Cl and 50 per cent Phosgene.

Winter, 90 per cent Cl and 10 per cent Phosgene.

Chlorine and Phosgene belong to a class of gases called asphyxiants. They attack the lungs and cause death by suffocation. Each lung is filled with air spaces and cells, the latter taking up the oxygen from the air and transferring it to the blood. Chlorine destroys the layer of cells so it cannot function and death results. It also causes the cells to exude matter which does not dry up but fills the lungs with liquid mass. Table of concentration for Chlorine:

1 in 10,000 will knock a man out in five minutes.

1 in 100,000 for five hours will cause Bronchitis.

1 in 28,000 for five minutes will cause pneumonia.

Concentration aimed at in gas attacks is 1 in 2,000.

**Chlorine.**— Chlorine is 2.5 times heavier than air. Hence rolls along the ground. Greenish yellow in color.

**Phosgene.**— Phosgene is 3.5 times heavier than air. It is colorless. Acts as an asphyxiant but is only half as strong as chlorine. It also has a delayed action on the heart, which acts two days afterwards. Hence in trenches after an attack troops and horses are rested for 24 hours, for any exertion by a man who has been gassed by Phosgene makes the effects much worse. Fresh troops take their places. Phosgene smells like musty hay.

Action during Wind Dangerous Period.— As soon as wind is discovered to be dangerous, notices are posted to that effect. Five to 8 m. p. h. is the best speed. Favorably, steady wind must be waited for; hence, if the enemy sees that wind is blowing from our trenches toward them, they prepare for a gas attack.

**Wind Observations.**— Wind observations are made every three hours:

1. To determine direction of wind.
2. To determine strength of wind.

**Gas Alarms.**— Methods of giving the alarm are prepared as follows: Sentries put all along front to watch for gas. Every "bay" has a sentry. The alarm is given by striking an empty shell case with a piece of iron or wooden mallet. These are called Lateral Alarms. Strombos horns are also used — 14 to one mile of front — and extend back to rear of lines. These horns are blown by compressed air and may be heard 400 to 500 yards.

Each sentry, posted by lateral alarms or strombos horns, has two men near by to warn all men sleeping in dugouts. Headquarters and Signal dug-outs all have sentries. Artillery observation posts are also warned. During Wind Dangerous all masks are worn at the alert position and are inspected every day.

The Company Gas N. C. O. reports to Company Commander to give advice, if needed. Men in front line trenches sleep on fire step during Wind Dangerous period, and men in front or rear sleep with mass at the alert position.

Men in billets must be warned.

Children playing in the streets wear masks strapped on. Rifles are smeared with oil or vaseline to protect metal from gas.

**Action During Gas Attack.**— Sentry can tell in three ways that gas is coming: 1. Hear it escaping from cylinders. 2. See cloud coming. 3. Smell the gas. Upon perceiving gas attack, sentry holds breath, gives alarm, puts on mask and continues to give

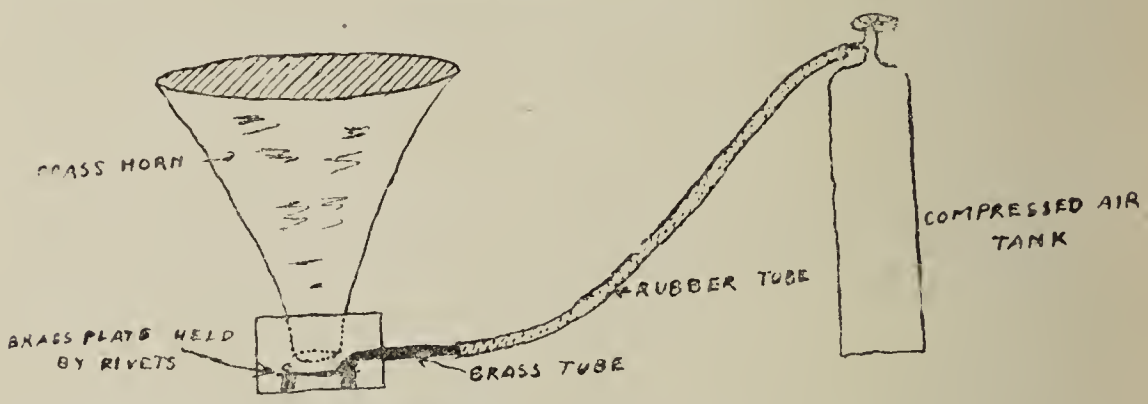
alarm. All unnecessary movement must cease. Working parties and reliefs stop. Sentries lower blanket door at dugouts. Sentry holds breath, lowers first blanket, passes through and lowers second blanket, and then puts on his mask.

G-A-S is sent back to artillery if attack is not accompanied by infantry. If followed by infantry S-O-S is sent. Men in front line trenches mount fire step and commence a slow rate of fire. This helps to protect the inside of rifle barrels from gas and also steadies the men.

Cloud attacks now very few due to warning given by the wind and men are not surprised. Only used now against untrained troops with little or no anti-gas training. (With only three days' training 1,600 Germans were killed by one gas attack.)

**Mechanism of Strombos Horn.**— Each Strombos Horn has two compressed air cylinders, one attached and the other in reserve. Pressure of air in cylinder should be 175 kilograms per sq. cm. and must never be less than 150 kilograms per sq. cm. Strombos Horns are placed in horizontal position to protect from rain.

STROMBOS HORN.




Distance apart is 400 yards.

They are placed in the first, second and third lines.

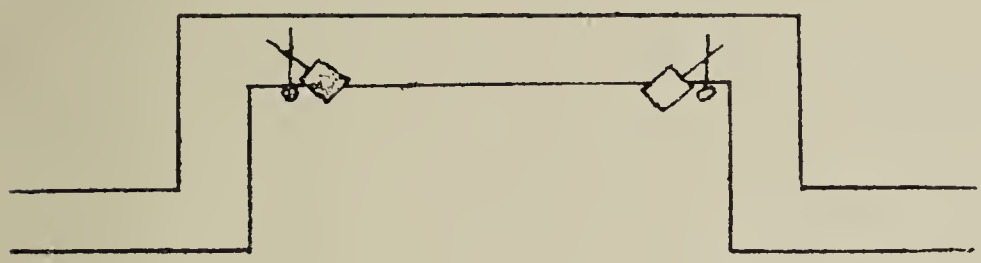
Gives a "G" note on the bugle.

Brass plate vibrates — compressed air rushing down onto bross plate causes it to vibrate, giving it the sound of a "G" note on the bugle.

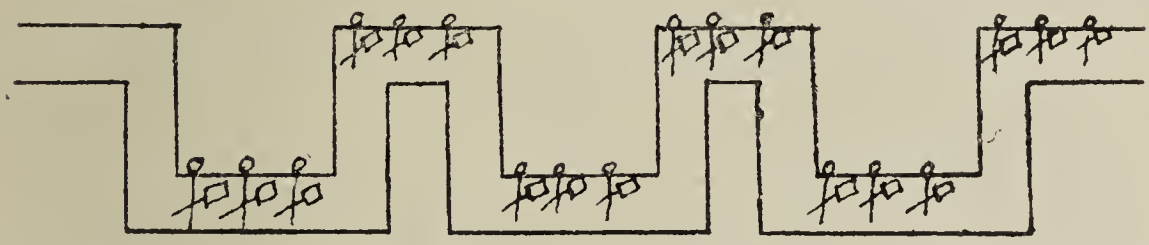
Two cylinders are with each horn; after an attack old cylinder is disconnected and new one attached, waiting for the next gas attack. One sentry is posted over each strombos horn.

## 17. METHODS OF GETTING GAS OUT OF TRENCH.

Two men in step and coming toward each other.



Three men in each sector, going in the same direction and in step.



Clearing dugout:

1. By natural ventilation it takes from four to six hours to clear a dugout of Chlorine or Phosgene.
2. Tear Gas takes from three to four days.

Fires in dugout.— Always wear mask.

### 18. Second Lecture.

**Action After Gas Attack.**— Before respirators are removed the trenches and dugouts must be cleared of gas. The gas settles into all holes at bottom of trenches and is cleared by fans or fires. Fans used chiefly in trenches. Men using fans work out of step. When they face each other they work in step. If men have been even slightly gassed they should not be allowed to help clear trenches.

**Clearing Dugouts.**— There are three methods of clearing dugouts: 1. Natural Ventilation.— Chlorine and Phosgene take from three to six hours to get out by natural ventilation.

2. By Fires.— Fire is made in center of double entrance dugout, six inches above level of floor, in a brazier or pail. One pound

of wood used for 200 cu. ft. of air space. In single entrance dugout fire is built in passage one-third way from dugout. In a dugout with steps leading into it, fire is built on steps near entrance.

3. By Fans.

Action of Gas on Rifles, Ammunition and Equipment.— Chlorine is the chief gas acting on the metals. Therefore, all guns, mechanisms and bright parts of instruments are covered with light oil or vaseline. Ammunition, bombs, etc., are stored in compartments protected from gas by heavy blankets. To counteract action of gas in rifle barrels a solution of soda is poured down barrel and then properly cleaned with oil. In case of wounds Chlorine gas acts as an antiseptic. Does not harm food; may be slight taste.

### Effect of Gas on Rifles, Ammunition and Equipment.

The chief gas that acts is Chlorine:

Brass and copper: Blue powder.
Steel and iron: Rust.

All rifles, ammunition, signal apparatus and bombs should be covered with ordinary rifle oil, *i.e.*, 3 in 1 or vaseline.

Use vaseline if available, if not oil is the next best for this purpose.

Blankets are sprayed with water.

Hinges are covered with flannel or cloth and soaked in water.

Acid will form in rifle barrels, and care should be taken to pour soda into them after every attack by gas, as acid will spread immediately.

No dangerous effect on food except on canned goods that are open.

If wounded in a gas attack the chances of recovery are better than if wounded elsewhere.

Protected Dugouts.— Most of the second and third line dugouts are protected, most of the doors having double blankets, looping into dugouts.

There are no protected dugouts in the front line trenches. Dugouts in second line and support lines are protected by double door of blankets.

**Construction.**— Blankets rest against beams with roller which holds them tight to the beams. Blankets are soaked in substance which absorbs water. They are sprayed once a week with ordi-

nary hype or a compound (Vermorel Spray). 1½ lbs. Hype. 3 lbs. soda, 3 gal. water.

Rollers extend over edge of blankets and hang on nails at top of entrance when blankets are rolled up. Dangerous to sleep in dugouts, with men going in and out, without respirator near.

When wind is dangerous or likely to be so, wind observations and reports are made every 3 hours by every Company Commander in front line trenches, and if situation warrants, Wind Dangerous or Gas Alert is ordered from Brigade Hdqrs. In making out wind reports the direction and strength of the wind must be known.

**Beaufort Scale.**

| Beaufort No. | Speed m. p. h. | Natural Objects. | Behavior of Flag. |
|---|---|---|---|
| 0 | 0 | Smoke straight up. | No movement. |
| 1 | 2 | Smoke slants. | No movement. |
| 2 | 5 | Felt on face. | Slight movement. |
| 3 | 10 | Paper, etc., moved. | ¾ up. |
| 4 | 15 | Bushes sway. | Up, falling down. |
| 5 | 20 | Tree-tops sway. | |
| | | Wavelets on water. | Up, falling less often. |
| 6 | 30 | Trees sway and whistle. | |

Wind Report.

Trench No. 303 December 6, 1917

| Time | Direction | Strength, M. P. H. | Remarks |
|---|---|---|---|
| 10.30 a. m. | S. SW. | 5 m. p. h. | Gusty. |

## FIRST AID TO GASSED.

### 19. Third Lecture.

First thing a wounded man tries to do is to tear off his helmet, which is fatal if any gas is present. Hence everyone should try to prevent this if possible. Next get him as high out of the gas as possible, and into a protected dugout. After getting him to protected dugout and mask removed, have him smell a capsule of aromatic spirits of ammonia. Next make him vomit. REST is the chief medicine. He must be treated as a stretcher patient and sent to hospital as soon as possible.

Masks should be inspected in the prescribed manner, very carefully.

Carbon monoxide is not used directly in attacks, but has caused many casualties. It attacks the blood corpuscles and they no longer carry oxygen. It is a very light gas — lighter than air — so cannot be used as a cloud gas. Cannot be easily liquified, so cannot be used in gas shells. No respirators protect against this gas. Gas forms when carbon burns in very little air, in confined space. When any high explosive bursts in a confined place, carbon monoxide is formed. As a protection from this gas Salvus Sets are issued to machine gunners and some batteries. A salvus set cuts a man off entirely from the outside air. Consists of a cylinder of oxygen opening into bag of waterproof material, from which issues a tube leading to mouthpiece.

If a man gets gassed by CO, artificial respiration is the only thing of any use. This is the only case in which artificial respiration is used in gas cases.

Smoke warfare has been increasing in the last three or four months. Smoke is used of various colors, fired from all kinds of guns, trench mortars, bombs and stokes guns. There are two kinds: 1. Type S — ignited by fuse; 2. P. bombs — filled with red phosphorous and exploded by detonator. Uses of smoke:

1. Chlorine gas cloud attack, combined with smoke, now employed a great deal. Saves a great deal of chlorine. Helps to lower enemy's morale.

2. Assume that we are to concentrate troops at one point. To keep enemy from learning this, we screen the concentration by smoke for miles on either side.

3. In actual attack, nearly always, infantry advance is screened by smoke.

4. Smoke used for screening positions from aeroplanes.

5. Some barage placed on flank during a retirement so as to prevent exposure to hostile fire.

**Gas Shells.**— Gas shells are ordinary shells from which the greater part of explosive has been taken and replaced by a poisonous liquid, which, when the shell bursts, turns into a poisonous vapor or gas, and being heavy, hangs about the place where the shell bursts. In some cases, a lead container has to be used for the liquid, but in most cases the liquid is poured into the shell. Only enough explosive is used to burst the shell and set the gas free.

Gas shells were first used by the Germans in October, 1915, and the Allies began to use them shortly afterwards. The first gas shells were fired indiscriminately and did little damage: 1. On account of small bursting charge they make a very small explosion. 2. Having such a great deal of liquid in them, a very curious, wobbly sound is produced as they go through the air. 3. The shell on bursting, produces a whitish cloud, which hangs over the place of bursting.

By above characteristics gas shells were recognized.

## Nature of Armament.

| Allies. | German. |
|---|---|
| 75 mm. (Trench). | 15 cm. Howitzer. |
| 4.5 inch (Howitzer). | 10.5 cm. Light Howitzer. |
| 4.7 inch (Field Gun). | 7.7 cm. Field Gun. |
| 60 Pounder. | Minenwerfers (Trench Mortars). |
| Livens Projector (new gun like Trench Mortar). | |

With above guns gas shells can be thrown anywhere within five miles.

Gas shells are divided into four main divisions, according to chemicals inside.

1. **Asphyxiants.**—Attack lungs, causing death by suffocation, Cl, Phosgene, K substance.

2. **Paralysants.**—Attack nerve centers. Prussic acid (usually mixed with other poisons of like nature).

3. **Lachrymatory.**—Attacks eyes, causing intense pain and tremendous flow of tears. From 1 in a million to 1 in five million knocks a man out. Has no permanent ill effect. Germans use benzyl bromide.

4. **"Mustard Gas."**—Only used since July, 1917, by Germans. This shell contains heavy liquid which does not evaporate easily and affects the skin, forming ulcers, sores, etc. Affects especially the tender parts of the body. This gas hangs low and may be picked up by anyone by touching dirt near the place of bursting. This gas causes a loss of the sense of smell for other gases temporarily.

Action is on eyes, causing intense pain and running of pus for three months, and sometimes permanent blindness. If this gets on hands, face or between the legs, it causes nasty sores which are incurable.

Sometimes the officers wore the mask in the alert position, not putting mask entirely over the face, but inserting the mouthpiece and fastening the nose-clip. This has been discontinued as the Germans soon discovered this fact. Do not touch the eyes with the hands.

All gas shells are painted grey in color with identification marks painted on.

*Marks on Shells.*

Shells are painted light grey, with various markings, according to the gases they contain.

Asphyxiant Shells.—Grey and light grey marks.

Lachrymatory Shells.—Grey and black band.

All shells are marked.

Gas shells are used in the following ways: 1. To prevent concentration of troops, supplies, etc., back of the lines. 2. Used for counter-battery work. 3. Used for lowering morale of opposing troops.

Lachrymator shells are used against a position which you desire to deny the enemy and do not wish to occupy yourself.

Asphyxiants and other gases are used against positions which you desire to deny the enemy and do wish to occupy yourself.

Alarms for Gas Shells.— Success of gas shells is due to surprise. They are mixed with other shells, so men must always be on the lookout for them whenever there is a bombardment. Local alarms are used for gas shells. Alarm may be given by shouting Gas Shells or by using a rattle, depending upon proximity of shell.

For Gas shells the wind must be under 5 m.p.h. Fog or gentle rain is very good for these attacks. Objective of attack usually woods, bushes, or low ground. Heavy rain, a high wind or sun shining and barometer low are very unsuitable conditions.

Men should be trained to get masks on in 7 seconds from the slung position and 6 seconds from the alert position.

Time in seconds for gas cloud to reach us from enemy's trenches:

$$\frac{\textit{Distance in yards} \times 2}{\text{m.p.h.}}$$

## PART 3.— PRELIMINARY DRILLS WITH BOX RESPIRATORS.

20. **Practice "A."— Adjustment of the Box Respirator in the "Alert" Position.**— Hang the box respirator round the neck with the press buttons next the body. With the right hand seize the satchel by the leather tab, with the left hand seize the sling by the brass button and clip this into the leather tab. Undo the press buttons, closing the satchel.

The length of whipcord will then be withdrawn from the right-hand compartment, passed through the ring on the right of the satchel and carried round the waist to the ring on the left, where it is fastened. The press buttons closing the satchel will be left undone, but the flap will be put in position to keep the respirator from wet.

**Practice "B."— Drill "by numbers" To Obtain Correct Adjustment of the Box Respirator.**— Note.— This drill is to be carried out alternately with one "judging the time," *i. e.*, as quick adjustment as possible. It is the most important and complete adjustment must be obtained by all ranks in SIX SECONDS.

Adjust the respirator in the alert position with satchel covered but not buttoned.

1. On the command "One" place the left hand on the left cheek and knock off steel helmet on to left wrist from behind with the right hand, press down both thumbs between the satchel and the body and open the satchel flap. Immediately seize the mask with the right hand, the metal elbow tube just outside the mask being in the palm of the hand and the thumb and first finger grasping the wire frame of the nose clip.

2. On the command "Two" bring the mask smartly out of the satchel and hold it in both hands with all the fingers outside found the binding and the two thumbs inside, pointing inwards and upwards under the elastic. At the same time throw the chin well forward ready to enter the mask opposite the nose clip.

3. On the command "Three" bring the mask forward, digging the chin into it and with the same motion bringing the elastic bands back over the crown of the head to the full extent of the retaining tape, using the thumbs.

4. On the command "Four" seize the metal elbow tube outside the mask, thumb on the right, fingers on the left — all pointing towards the face. Push the rubber mouthpiece well into the mouth and pull it forward until the rim of the mouthpiece lies between the teeth and the lips and the two rubber grips are held by the teeth.

5. On the command "Five" adjust the nose-clip to the nose, using the thumb and first three fingers of the right hand. Run the fingers round the mask on either side of the face to make sure that the edges are not folded over. Correct any faults in adjustment. Come smartly to attention.

**Practice "C."— To adjust Box Respirators when carried over the shoulder and not in Alert Position.**— Sling the satchel round so that it hangs in front of the body. Undo the press buttons and adjust the mask as in Practice "B," allowing the satchel to hang by the rubber tube.

After the nose-clip is put on, at once proceed to adjust the satchel in the alert position, as in Practice "A." Standard test 7 seconds.

**Practice "D."—Drill to teach cleaning of eyepieces.**— On the command "Clean Eyepieces" the right eyepiece will be gripped between the thumb and the first finger of the left hand. The

first finger of the right hand will then be pushed gently into the fold of the mask behind the right eyepiece which will be cleaned with a gentle circular motion.

The left eyepiece will be cleaned in a similar way.

**Practice "E."—Drill to teach method of giving orders.**—It is first explained to a squad that the nose-clip must not be removed to talk and that before each sentence is spoken a long breath must be taken and the mouthpiece removed sideways from the mouth by turning the metal tube outside the mask to one side. After speaking, the mouthpiece is replaced.

The squad should then be numbered off, extended to four paces, and orders passed along the line.

Officers and N.C.O's. will receive special care in Practice "E."

**Practice "F."—Drill to teach method of clearing mask from gas which may have leaked in and is affecting the eyes.**—Press the mask close to the face, forcing out foul air round the sides and then fill again with fresh air from the lungs by blowing out round the mouthpiece.

**Practice "G."—Drill to teach method of testing whether trench or dug-out is free from gas.**—With the right hand open the face-piece away from the right cheek, then loosen the nose-clip on the nose and smell gently (do not take a breath). If gas is smelt, the nose clip and mask are replaced. Then as in Drill "F."

If no gas is smelt, left hand removed from nose-clip and placed under face-piece on left cheek. Mask then removed with both hands.

**Practice "H."**—Ordinary infantry drill will be carried out while wearing the mask. This will include doubling for at least 200 yards at a time. Marching order will be worn. Musketry and bombing instruction and training of specialists (including artillery, machine gunners, signallers, medical corps) will also be carried out.

21. **Directions for use of Box Respirators.**—At ordinary times, the haversack containing the Box Respirator is to be carried slung over the right shoulder, WITH THE FLAP FASTENERS NEXT THE BODY.

**(A) To Change to the Gas Alert Position:**

(1) Pass the left arm backwards through the sling so that the haversack hangs in front of the body.

(2) Raise the haversack on to the chest by pulling the sling with the left hand until the brass stud on the sling is low enough to button on to the leather tab on the left side of the haversack.

(3) Take the coil of whip cord out of the haversack, pass it through the ring pointing to the right of the haversack, round the body, and tie it firmly to the ring pointing to the left of the haversack.

(4) Unbutton the snap fasteners, but keep the flap closed towards the body to protect the respirator from wet.

**(B) On the Sounding of the Gas Alarm:**

(1) Open the haversack by pulling the cover forward, and grip the mask with the right hand.

(2) Take the mask out of the satchel and seize it with both hands, the fingers gripping the edge of the mask and both thumbs pointing inwards and upwards UNDER the elastic. Throw the chin well forward ready to enter the mask.

(3) Push the chin well into the mask and at the same time draw the elastics over the head AS FAR AS THEY WILL GO, *i. e.*, till the central tape is tight.

(4) Holding the metal mouth tube in the right hand outside the mask, push the rubber mouthpiece well into the mouth and draw it forward so that the rubber flange is between the teeth and the lips, and grip the two small rubber projections with the teeth. Then start breathing in and out through the tube.

(5) Open the nose clip by pinching from the outside the circular wire spring below the goggles; push the clip buttons on to the lower part of the nose and release the spring, making sure that the nostrils are closed.

(6) Complete the fitting of the mask by pulling it well on over the jaw and by smoothing the edge all around the face.

(7) Do not attempt to speak while wearing the respirator except in case of necessity.

(8) If it is necessary to speak, breathe in deeply, grasp the metal tube outside the mask and carefully remove the mouthpiece from between the lips — care being taken not to move the nose-clip.

(9) After speaking, immediately replace the mouthpiece and make certain that the nose-clip is properly adjusted.

(10) If the eye-pieces become dull they can be cleaned by inserting the forefinger into the pockets alongside the goggles and wiping the inside of the windows. The eye-piece is held with the other hand while this is being done.

(11) If the nose-clip slips off the nose, replace it at once.

(12) After use, carefully dry the mouthpiece and eye rims from the inside and also inside surface of the mask, so as to remove the condensed moisture resulting from the breath.

## TO INSPECT RESPIRATORS.

22. **Masks are slung, boxes opened and respirators taken out.** Respirators proper are inspected first:

1. Inlet valve.
2. Box of chemicals.
3. Shake well before using.
4. Connections.
5. Tube,— flexible — no holes and in good order.
6. Elbow piece firmly attached.
7. Rubber outlet valve.
8. Elbow tube to face.
9. Mouth piece.
10. Nose piece — not too loose, good grip.
11. Eye piece, fabric is caught up.
12. Face piece itself.
13. Elastic, and retaining tape.
14. Test both valves.
15. Haversack — every thing present.

For the above inspection the usual commands of "Open ranks."

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PHOTO SHOWING FRENCH RETIRING BEFORE GERMAN GAS ATTACK.

Most unusual and striking photograph taken by a daring photographer on the French fighting front. The picture shows a wave of German poison gas coming directly for the French lines. The soldiers are shown falling back towards the second line trenches to allow the deadly gas to pass on. In the foregound is a French soldier watching the movement from one of the communication trenches.

# CHAPTER II.

## LECTURE ON GAS FOR OFFICERS.

### Introduction.

23. Gas in warfare is not an entirely modern invention but is simply another reversion to primitive methods many examples of which can be found in the present conflict. Ancient history is replete with mention of "suffocating smoke," "stink-pots," "flaming pitch" and "burning oil," the forerunners of our modern gas and liquid fire. We have simply improved the methods. Even the ancient catapult has found its place in modern war to throw grenades and bombs. No mention has been made of the "crossbow" but, if it has not already appeared on the European battlefields it no doubt will for it would be an admirable weapon for throwing small grenades; cheap to operate, silent, light in weight and more accurate than the hand.

The use of poisoned gas in the present war, like all the cruel and less chivalrous forms of fighting, was introduced by the Germans, the first attack being at Ypres on April 22nd, 1915. It caught the allied forces unprepared, killing and poisoning large numbers.

### Organization and Instruction.

24. The present English field system consists of a complete organization at the head of which is a Chief Chemical Adviser. Each command has a Chemical Adviser, each Division a Division Gas Officer, each Brigade a Bde.G..O., each Battalion a B.G.O. Many non-commissioned officers have qualified for special work in this branch. Each Battalion should have in addition to its B.G.O. four N.C.O's. who have qualified and one or two N.C.O's. of the Medical Corps. Frequent changes are made in protective methods and it is the business of this organization to carry out these changes in the units to which they are attached.

The French do not have a separate field organization. Each division has a chemist who analyzes the gases used by the Germans, but beyond this the details are looked after mostly by officers of the medical corps.

In both armies samples of every attack are taken and analyzed to detect the presence of any new gas. These samples are obtained by breaking the seal of a vacuum bottle, or by empty-

ing water out of a bottle while the attack is on, then sealing it and forwarding to the division chemist.

Gas as a weapon has long passed the experimental stage and is now an established method of offense. Consequently all armies have recognized the necessity of instruction and frequent drill in defensive tactics. It is just as important for men to know how to adjust masks and helmets in seven seconds as it is to shoot with the rifle. A man may escape all kinds of bullets and bayonets but without some method of filtering the air that he breathes he hasn't one chance in a million of escaping gas.

Men should be subjected to gas so they will appreciate the protection of the anti-gas appliances. This is very effectively done by subjecting them to lachrymal gas with helmets or masks and then without. This may be done without actual casualty but serves to give men a very distinct and lasting impression of the difference between meeting gas with a mask and without it. Men should also have an opportunity to see a gas cloud so they may know what it looks like and how it rolls along. To see a gas cloud for the first time under battle conditions must be rather terrifying. They should also be able to distinguish between the burst of a gas shell and the ordinary shell.

## Forms of Gas Attack.

25. There are various methods of gas attacks:
    a. Emanation.
    b. Cloud or mist.
    c. Chemical shells.

1. Emanation. This is the least important method and consists of scattering chemicals about trenches which are to be deserted. This chemical when brought in contact with moisture or stirred up by the digging of occupying troops produces a poisonous gas.

2. Cloud or mist. This method consists of bringing gas up to the front line in cylinders or tanks under heavy pressure and releasing it when the wind is in a favorable direction for carrying it over enemy trenches. If it is a clear dry day the gas rolls along close to the ground, a faint green mist gradually growing thinner and less deadly as it advances and dissipates. If the day is damp the gas, which has a strong affinity for moisture, takes on the appearance of a greenish yellow cloud

bank. It is often harmless at 200 yards but again it has been fatal after traveling two miles.

3. Chemical shells. While the amount of gas in this method is small in comparison with the cloud attack it is nevertheless very dangerous because there is no warning. In cloud attacks, the very direction of the wind is a warning but the use of shells is independent of wind. This method is used against the artillery which is usually too far back to be affected by cloud attacks except under exceptionally favorable circumstances.

The average shell contains about five pounds of gas in liquid form which expands when released by the explosive charge, in about the same ratio as water to steam. A very heavy attack with these shells at one point produces the same effect as a cloud attack, but with the added element of surprise. This form of attack is becoming more popular with both contestants than the cloud attack.

## Kinds of Gas.

26. There are a great many kinds of gas. Old ones are becoming obsolete and new ones are being evolved every day.

The chemical used for Emanation was Calcium Arsenide. When brought in contact with moisture it generates "Arsene" a gas of faint garlic odor. It is not much used as it does not generate in large enough quantities to be particularly dangerous.

Chlorine, Bromine and Phosgene have been the chief chemicals used in the cloud attacks. The latter (Carbonal Chloral) is a composition of carbonic acid and chlorine.

Methyl Sulphate and Pelite are two of the poisonous gases used in shells. The German tear shells are of two kinds; one known as "A" shells which contain Bromaceteone and the "T" shells containing Xylylbromide.

Other gases are hydrogen sulphide, formol and anhydrous compounds of nitrogen.

Prussic Acid (hydrocyanic acid) has evidently not been used much as very little mention of it has been made in reports from the front.

## Effects of Gas.

27. Not all gases are intended to kill. Some like the German "A" and "T" shells are intended to temporarily incapacitate the enemy while a charge is being made for the purpose of taking prisoners or finishing the job with bombs or bayonets.

The Bromacetone and Xylylbromide of these German shells are classed as lachrymal gases because they directly affect the lachrymal or tear glands of the eye causing a copious secretion of tears and smarting of the eye which temporarily blinds the enemy. There is a very strong tendency to rub the eyes but this should be avoided as it only produces a more serious inflammation.

The effect of Chlorine and Bromine depend on the amount of gas in the atmosphere. Both kill by suffocation when in sufficient quantities. One part of Chlorine to one thousand parts of air will cause paralysis of the glottis (the valve at the opening of the windpipe) and men will tear their throats open with their fingers in their efforts to get air. When the mixture is 1-5000 death is caused by a very acute inflammation of the lung structure. The victim suffers for some time finally dying in agony after a frothy hemmorrhage of the lungs. 1-50000 is less violent but causes death in a few days by gangrene of the lungs. Bromine effects are identical but more violent.

Phosgene gives a different effect but the final result is the same,—death. Men attacked by Phosgene feel no serious effects for hours and continue about their duties only to suddenly sink into a fatal collapse with all the symptoms of heart failure. Early in the war the French losses were very heavy from this gas. The English warned of its probable use had made preparations to fight it and suffered few losses.

The anhydrides when they come in contact with the moisture of the lungs, like phosgene, form acids corresponding to their bases, with similar effects.

The effects of Prussic acid gas are entirely different from the other gases. It acts directly on the nervous system, in dilute form produces dizziness, headache, pains in chest, and difficult breathing, coma and sometimes convulsions preceding the end. In concentrated attacks the victim becomes unconscious, and death follows almost immediately.

It would not be proper to go into details regarding the new gases and chemicals of the Allies but suffice it to say that they have a "weeper" (tear bomb) that "out weeps" anything the Germans have produced. This bomb is known to "Tommy" as the "S. K." from the fact that it was originally manufactured at South Kensington. They also have another chemical bomb which

poisons everything within the radius of its explosion and against which there is no complete protection.

## Gas Masks.

28. When the allied forces were caught in the first gas attacks, a few men recognized the Chlorine gas. Knowing its affinity for moisture and the neutralizing effects of certain excretions of the body they wet their handkerchiefs, coat sleeves and even the sandbag revetments, sucking air through these improvised filters and thereby cheating the gas of thousands of victims.

To-day the accepted methods of defense are the gas mask or helmet and the respirator. There are various kinds of these appliances but they may all be divided into two types — the P. H. Helmet and the Box Respirator. A third consisting of goggles with heavy soft rubber rings fitting closely around the eyes was used as a protection against lachrymal gas but this protection is now incorporated in the P. H. Helmet and Respirator.

The P. H. Helmet consists of a double flannelette bag with two eye pieces and a mouth piece consisting of a hard tube on the inside and a flat piece of rubber on the outside through which the breath can be exhaled but which collapses if attempt is made to inhale through it. The flannelette is impregnated with solutions of Carbolic Acid and Phenol, Caustic Soda, Hexamine and Glycerine. The Carbolic Acid and Phenol which produces a rather annoying tickle in the throat is the neutralizing agent for the Chlorine Gas. The Caustic Soda is a protection against Prussic Acid. The Germans had not used this acid at the time this alkali was first used in the helmets. This alkali also neutralizes the acid producing gases. Hexamine, a chemical discovered by a Russian chemist, takes out the Phosgene. The Allies were warned of an impending attack of this gas and the English immediately adopted this chemical. The French did not use it and lost heavily in the first attacks. German gas helmets captured a few weeks later were found also impregnated with Hexamine, which they had evidently discovered in the helmets of some English prisoners. The Glycerine is used to hold the chemical solutions and prevent their evaporation. The helmet is carried in a rubberized pouch. Signal stations, command posts, dressing stations and dugouts for troops in the support line when within the zone of gas attacks,

are sometimes provided with blanket curtains impregnated with these chemicals, although usually these curtains are simply dipped in water which serves as a door to keep out the gas.

The French type anti-gas appliance is a true mask. It is made up of several layers of gauze, each saturated with chemical and is molded to fit under the chin, up the sides of face and across the forehead. Each man must be fitted and must retain his own mask. The goggles in these masks are made of cellulose acetate which will not break or fog from the breath, and is also equipped with a water-proof apron which protects the mask from rain. The mask is held in place by heavy elastic bands around the head, and also has a loop of tape by which it can be suspended from the neck in "Gas Alert." There is also a water-proof pouch with tape sling for carrying over shoulder and this in turn can be carried in a metal container with short leather sling which attaches to belt.

An American has made a remarkable discovery in regard to the goggles for gas masks. He has found that two pieces of glass cemented together will not crack or break. In fact it is possible to drill a piece of glass so constructed with an ordinary steel drill.

The Box Respirator (small type) consists of a small canvas haversack, called a satchel, of two compartments, one of which contains the metal filter with its charge of chemicals; the other, the mask, called the facepiece, is made of rubberized material with mica eyepieces, a nose clip, a rubber mouthpiece shaped to be gripped in the teeth and terminating on the outside in a flat rubber valve similar to that on the P. H. Helmet. Connecting the mask and the filter is a short length of non-collapsible tube. The mask fits the face closely and is held in place by broad elastic bands passing around the head. On the right side of the satchel is a small button and in the sling which normally passes over the left shoulder is a button hole so that the satchel can be carried on the chest by passing the sling about the neck and hooking on button. This is known as the "alert" position. There is also supplied a piece of whipcord which can be passed through rings on sides of satchel and around the body to prevent satchel being displaced while in action. The French have a Box Respirator of this same type but which is much larger, the box being carried on the back.

## Equipment of Men.

29. The Box Respirator is now considered the chief means of defense with the P. H. Helmet or Mask as an auxiliary, in case the Respirator should be injured. Each man is therefore supplied with both types. The Box Respirator is slung on the right side, the strap passing over the left shoulder. The P. H. Helmet is slung from the left shoulder and hangs perpendicularly downward, the sling passing under the belt. BOTH APPLIANCES MUST BE OUTSIDE ALL OTHER EQUIPMENT.

## Inspection.

30. One of the main causes of fatalities in gas attacks is the use of faulty helmets or respirators. The only method of combating this is by frequent inspections. These inspections should normally be held at least once a week, and during periods when conditions are favorable for a gas attack there should be daily inspections.

The following instructions are issued regarding these inspections:

### A. Box Respirators:

(a) Box, face-piece, nose-clip, mouth-piece, eye-pieces and elastic must be in good order.

(b) Face-piece must be firmly attached to the mouth-piece and to the elbow tube.

(c) Metal tube inside mouth-piece must be about $\frac{1}{8}$ inch back from the opening of the mouth-piece.

(d) Rubber tube must be intact and firmly attached to the box and elbow tube.

(e) Expiratory valve must be tested by removing the box from the satchel and pinching the rubber tube so as to prevent inlet of air, at the same time attempting to draw in air through the mouth-piece. It should not be possible to draw in any air.

(f) See that air can be drawn freely through the box.

(g) Whipcord must be present and not knotted.

(h) Any small perforations in the face-piece must be temporarily repaired by applying pieces of adhesive plaster from the repair outfit to the perforation, both inside and outside the mask. The adhesive plaster must be large enough to overlap the hole all around.

(i) Replace the box in the satchel so that the face-piece comes to the face without twist on the tube. Fold face-piece carefully and replace in the satchel so that the expiratory valve is not likely to crumble.

B. P. H. Helmets:

(a) Satchel and wallet must be in good order.

(b) Helmet must be properly folded with the valve flat and no strain on the flannelette round the valve seating.

(c) Joint between parts of the valve must be tight and should grip the flannelette. Mouth-piece should be horizonal. Rubber valve must be fastened securely to the metal. Valve must be tested by breathing through it. It should not be possible to breathe in through it. The valve rubber sometimes becomes hard; this is remedied by breathing out through the valve for about a minute at each inspection.

(d) Eye-pieces must be screwed up tightly from the inside and must grip the flannelette. Screw threads must not be crossed. Glasses must not be cracked or loose.

(e) There must not be the smallest hole through which gas might enter. Particular attention must be paid to the flannelette round the eye-pieces and valve seating.

(f) If helmets become so sodden with water that it is impossible to breathe through them they must be condemned.

A supply of anti-gas stores are kept in the trenches such as fans, sprayers, grease, oil, spare cylinders, extra boxes for respirators and small boxes of chemicals.

Stores must be inspected every day by a non-commissioned officer to be sure that they are in good order.

## Materials Required.

2½% Lysol (1 tablespoon to a pint).
2 Pieces of cloth.
1 Small tin to hold disinfection.

## Gas Alert.

30. When conditions of atmosphere and wind are favorable for a gas attack preparations are made to meet it. This is known as "Gas Alert."

On the warning "Gas Alert," the right arm is passed back under Respirator sling and satchel is hooked so as to hang on the chest,

the loose end of sling being tucked in the compartment UNDERNEATH the face-piece. The satchel is then secured to the body with the whipcord and flap is unbuttoned. The chin strap of the steel helmet is placed over the back of the head so that the helmet can be quickly removed. Men should look over their equipment and see that there is nothing which might interfere even for a fraction of a second with the adjustment of the face-piece.

If a man is only equipped with the P. H. Helmet at "Gas Alert" he should proceed as follows: With the helmet over his head place the wallet or container on the chest with the open flap passed up under the front skirt of the helmet. Pin the front edge of helmet and the hinge of the open wallet to the shirt with two safety pins in such a manner that the helmet may be readily pulled on and off the head without removing the pins. Leaving the pins in position remove the helmet and fold in the regulation manner. The matter of folding is very important as on its correctness depends the efficiency of the valve and the quickness with which the helmet can be adjusted. The method is as follows:

Sides are folded over goggles, then crown is folded down over goggles. Next fold on a line between goggles and valves, being sure that valve lays flat when goggles are folded down over it. One more fold completes folding so that helmet can be put in pouch or carried under flap of wallet in alert position.

Great care must be taken to see that VALVE LAYS FLAT. If equipped with French mask on "Gas Alert" it is only necessary to remove mask from pouch and hang around neck by means of tape sling provided for that purpose.

## Gas Alarm.

31. In the front line trenches there is usually within reach of each sentinel a big klaxon horn or an empty shell case suspended on a wire. During daylight hours an approaching gas cloud can be seen through the periscopes. If the opposing trenches are close the peculiar metallic sound of the gas cylinders as they are brought up to the front line trenches is sometimes carried down the wind and gives warning of the attack. When the gas is released a loud hissing noise can be heard as it escapes through the valves. The Germans have recently tried to drown this noise by machine gun fire.

It is the duty of one sentinel on any of these indications of attack to sound the nearest klaxon or shell case. The other

sentinel must pass the word to dugouts, working parties, dressing stations, signal posts, etc., waking anyone that is asleep without regard for their feelings.

### Mask Adjustment.

32. On the sounding of the gas alarm, if wearing a respirator, quickly take the mask in both hands, the fingers along the edges of the mask, the thumbs supporting the elastic. Thrust the chin into the mask, at the same time carrying the elastic bands back over the crown of the head to the full extent of the retaining tape. Seize the metal breathing tube outside the mask, push the rubber mouth-piece well into the mouth and pull forward until the rim of the mouth-piece lies between the teeth and the lips and the two rubber grips are held by the teeth. Next, adjust the nose-clip to the nose.

If equipped with the P. H. Helmet carried in the alert position already described it will only be necessary to open the coat and lean forward so that the helmet falls. It will then be drawn over the head by both hands and gripped with the left hand tightly around the neck beneath the chin. This is the "Position of Safety." With the right hand tuck in the skirt of the helmet on the right side from front to back. Then the right hand will grip the helmet under the chin, while the left tucks in the skirt on that side. Special care should be taken to push the skirt of the helmet down at the back of the neck. Place the mouth-piece in the mouth with left hand and tuck the skirt inside the coat, button the coat and turn up the collar. The complete adjustment should not exceed 7 seconds.

With the French mask thrust the chin well into the lower part of mask and draw elastic bands over head to full extent of tape, being careful that mask fits tightly all around face.

### Gas Attack.

33. During a gas attack men should conserve their breath as much as possible. For this reason men should move about only as absolutely necessary. No talking should be allowed excepting necessary orders and these should be given by signal whenever possible. A close watch should be kept for men who are wounded or whose Respirators or Helmets may have been damaged. A wounded man will often tear off his helmet in an effort to get air. He should be forcibly restrained for if he succeeds he is

doomed. Should a Respirator go bad or be injured the change to the Helmet should be made as quickly and smoothly as possible WHILE HOLDING THE BREATH.

Men must not remove their masks or helmets after an attack until ordered to do so. They should then clean and dry their Respirator or Helmet and carry in the "Alert" position in preparation for another attack. Care should be taken that no one goes into any shelter or dugout until it has been ventilated unless wearing a Respirator or Helmet. This ventilation is accomplished by fanning about the shelter to produce a circulation of air. It may also be accomplished by building a fire.

After each gas attack arms and ammunition should be well cleaned and oiled, as the gas rapidly corrodes the bare metal.

When an attack is finally over, in addition to cleaning the masks the mouth-pieces should be disinfected by being dipped in a solution of Cresol or Lysol made by adding about a tablespoonful to a pint of water.

## Drill.

34. In order to make gas masks and helmets of any practical value it is necessary for men to learn how to adjust them without any lost motions and to carry on their usual duties while wearing them. To quietly sit through a gas attack wearing a helmet is one thing; to adjust it on a few seconds' warning and meet a bayonet attack, throw bombs or work a machine gun are different matters, and it is these things that count, for the gas attack is usually only a preliminary to an enemy attack.

For this reason men should be drilled in putting on the anti-gas appliances and also in all branches of the work while wearing them.

In marching men should learn to do double time for from two to four minutes. Bayonets exercise should be given but final assaults should never be made with Helmets or Respirators adjusted. In musketry the English use the following drill. With men occupying the 300 yard line the orders are given:

(1) "Gas Alert."
(2) "Fix Bayonets. Load."
(3) "Prepare to advance."
(4) "Advance." (Signal.)

Detail advances on the double to the 200 yard trench where the gas alarm is given. Helmets must be correctly adjusted in

20 seconds, the targets go up for 60 seconds during which time the men must fire ten rounds. After firing the officer in charge inspects the Helmets or Respirators and points out those which have become displaced or disarranged in such a way as to endanger the wearer.

Bombers, especially, must practice in gas helmets. Telephone operators must practice sending and receiving messages while wearing helmets. Lewis and machine gun teams must practice rapid loading, aiming and clearing jams. Ambulance men should practice stretcher drill with helmets on and, if possible, moving casualties into gas-proof dugouts. One man in four will simulate a casualty and endeavor to remove his helmet, the other three restraining him, tying his hands and carrying him to a place of safety.

ALWAYS REMEMBER THAT YOUR ANTI-GAS APPLIANCES ARE OF IMPORTANCE SECOND ONLY TO YOUR WEAPONS. KEEP THEM IN PERFECT CONDITION. YOUR LIFE MAY DEPEND ON THEM.

# CHAPTER III.

## DEFENSIVE MEASURES AGAINST GAS ATTACKS.

Every Officer is responsible that the men under his command are properly instructed in Defensive Measures against Gas Attacks, that all appliances are at all times in perfect order and that Standing Orders on the subject are thoroughly understood. During a Gas Attack it is important that all measures taken should be carried out with the utmost calm in order to avoid confusion and waste of energy.

## PART I.—INTRODUCTION. ORIGIN OF GAS ATTACKS.

35. The use of various gases as weapons of offense in the present war has become so general that in any training of troops in the future a thorough knowledge of the technique of gas attacks and the methods of defense against them must be included.

The use of gas, like many of the other weapons now in common use in the armies of Europe, such as the catapult, flame projector, trench knife, and sling, is an inheritance from the early ages, amplified, improved, and made more destructive by the aid of modern science.

The first recorded effort to overcome the enemy by the generation of poisonous and suffocating gases seems to have been in the wars of the Athenians and Spartans (431 to 404 B. C.), when in besieging the cities of Platea and Delium the Spartans saturated wood with pitch and sulphur and burnt it under the walls of those cities in the hopes of choking the defenders and rendering the assault less difficult. They also melted pitch, charcoal, and sulphur together in cauldrons and blew the fumes over the defenders' lines by means of bellows.

"Greek fire" was used by the Byzantine Greeks under Constantine about 672 A. D., to destroy the Saracens, and the Saracens, in turn, used it as a weapon of defense against the Christians during the crusades. This Greek fire had the double advantage of being not only inflammable, but also generating during the process of combustion, clouds of dense, blinding smoke and gas of an asphyxiating character. (This gas, sulphurous dioxide, is one of the gases used to-day.) Its chemical composition was supposed to be a mixture of quicklime, petroleum, sulphur, and such other inflammable substance as pitch, resin, etc. Upon the addition of water the slaking process which the quicklime underwent generated enough heat to ignite the petroleum, which, in turn, ignited the resin, pitch, and sulphur. This flaming mixture was delivered against the enemy by means of fantastic syringes in the shape of dragons and other monsters with wide jaws.

The first use of gas in modern warfare occurred April 22, 1915, when the Germans liberated great clouds of gas against the allies' trenches near Ypres, with a resulting complete demoralization of the troops and a large number of casualties.

Coincident with the use of the "gas cloud" the Germans began to use gas also in bombs, hand grenades, and shells. The world

was astounded at this resurrection of an ancient form of warfare, strictly forbidden by The Hague convention, but new weapons in war demand that they be met with similar weapons, and a week later the allies had agreed to manufacture gas shells and use gas in other ways in retaliation. From this beginning, gas has now become recognized as one of the accepted arms of the military service and is being used very extensively in all armies, especially in the form of gas shells.

## A.—GENERAL CONSIDERATIONS.

36. The following notes on defensive measures against hostile gas attacks have been compiled for the guidance of regimental officers in instructing their men and giving orders on this subject. They deal chiefly with the preparations necessary to combat such attacks successfully, and with the action to be taken during and subsequent to an attack.

37. In the absence of suitable means of protection the poison gases used in war are extremely deadly and the breathing of only very small quantities of them may cause death or serious injury. This being the case, it is essential that not the slightest time should be lost in putting on the box respirator or helmet on the gas alarm being given.

It cannot be too strongly insisted on that the measures which have been elaborated to meet hostile gas attacks afford **perfect protection,** and if they are carried out properly no one will suffer from gas poisoning.

38. The whole basis of protecting troops against gas lies (*a*) in keeping the appliances in perfect working order; (*b*) in learning to adjust them rapidly under all conditions; and (*c*) in ensuring that every man is given immediate warning. These results can only be attained:

**(i) By frequent and thorough inspection of all protective appliances.**

**(ii) By thorough instruction and training in their use.**

**(iii) By every man understanding and complying with all Standing Orders on the subject of defence against gas.**

If these are effectually carried out, there is nothing to fear from hostile gas attacks. Officers must impress this on their men, as an important object of all anti-gas instruction should be to inspire complete confidence in the efficacy of the methods which are adopted.

## B.—NATURE OF GAS ATTACKS.

Gas Clouds:

39. This method of making a gas attack is entirely dependent on the direction of the wind. The gas is carried up to the trenches compressed in steel cylinders. These are dug in at the bottom of the trench and connected with pipes leading out over the parapet. When the valves of the cylinders are opened, the gas escapes with a hissing sound, which, on a still night, can frequently be heard at a considerable distance. It mixes with the air and is carried by the wind towards the opposing trenches, spreading out as it goes forward. A continuous wave of gas and air is thus formed, the colour of which may vary.

(*a*) Because of the weather conditions. In very dry air it may be almost transparent and slightly greenish in color while in damp weather it forms a white cloud.

(*b*) Because it may be mixed with smoke of any color.

40. A cloud attack can only take place when there is a steady but not too strong wind blowing from the enemy's lines towards our own. A wind between 4 and 8 miles an hour is the most likely condition. An 8-mile wind will carry the gas cloud twice as quickly as a man walks rapidly.

Gas attacks may occur at any time of the day, but are most likely to be made during the night or in the early morning.

Gentle rain is without appreciable effect on a gas attack, but strong rain washes down the gas. Fogs have hardly any effect, and may, in fact, be taken advantage of to make an attack unexpectedly. Watercourses and ponds are no obstruction to a gas cloud.

41. The gas used by the enemy is generally a mixture of chlorine and phosgene, both of which are strongly asphyxiating. The gases are heavier than air, and therefore tend to flow along the ground and into trenches, shelters, craters and hollows. The gas cloud may flow round slight eminences, thus leaving patches of country which remain free from gas.

42. Chlorine and phosgene strongly attack the mucous membranes of the respiratory organs, causing bad coughing. In strong concentrations of gas, or by longer exposure to low concentrations, the lungs are injured and breathing becomes more and more difficult and eventually impossible, so that the unprotected man dies of suffocation. Death is sometimes caused

by two or three breaths of the gas. Even when very dilute, chlorine can be recognized by its peculiar smell, which is like chloride of lime, but stronger and more irritating.

Both chlorine and phosgene also exert a strongly corrosive action on metals, so that the metal parts of arms must be carefully protected by greasing them.

43. The speed with which the gas cloud approaches depends entirely on the wind velocity. Gas attacks have been made with wind velocities varying from 3 to 20 miles per hour, *i. e.*, from 1½ to 10 yards per second. In a 9-mile wind, the gas would reach trenches 100 yards distant in 20 seconds.

Gas attacks have been made on fronts varying from 1 to 5 miles; their effects at points up to 8 miles behind the front trenches have been sufficiently severe to make it necessary to wear helmets.

**Gas Projectiles:**

44. The use of these is not entirely dependent on the direction of the wind. In gas projectiles such as shells, hand grenades, and trench mortar bombs, a part or the whole of the expxlosive charge is replaced by a liquid which is converted into gas by the explosion. The explosive force and noise of detonation of these projectiles is less than that of the ordinary kind, and a large number of them are usually discharged into a comparatively small space. After the explosion, the irritant chemicals form a small gas cloud, though some may sink to the ground and remain active for a considerable time.

For using gas shells, the best condition is calm, or with a wind of low velocity. Nine-tenths of all gas attacks are shell attacks.

Gas projectiles can be used in all types of country. Woods, bushels and cornfields and clumps of buildings may hold the gas active for a considerable time.

45. Two kinds of shell gases are used by the enemy, viz., **lachrymators,** which mainly affect the eyes, and **poison gases,** which may affect the eyes and are just as deadly as the gases used in the form of clouds.

**Tear, or Lachrymatory Shells:**

46. These shells on explosion drive the liquid chemical which they contain into the air as a mist. They cause the eyes to water strongly and thereby gradually put men out of action.

Their actual smell may be slight. Large concentrations of lachrymators begin to affect the lungs and cause sickness, coughing and general irritation.

**Poison Shells:**

47. Besides the comparatively harmless lachrymators the enemy also uses projectiles which contain a gas, the action of which is very similar to that of phosgene. Because of their slight detonation, these shells are liable to be mistaken for blinds, but they emit large quantities of a gas which attacks the lungs strongly, and is very dangerous, and even in slight cases may cause serious after-effects.

**Smoke:**

48. The enemy may make use of smoke, either in the form of a cloud or emitted from shells and bombs. Smoke may be used with gas or between gas clouds; it may also be used alone to distract attention from a real discharge of gas, to cover the advance of infantry, or merely as a false gas attack.

**Mine and Explosion Gases:**

49. The poisonous gases which occur in mines, and which are formed in large quantities when high explosive goes off in an enclosed space, *e. g.*, from a direct hit in a shelter, or on the explosion of a charge in a mine, are not protected against by the ordinary anti-gas appliances. The chief of these gases is carbon monoxide. Protection against such gases will not be considered in these notes.

## PART 2.

## II.—ORGANIZATION OF GAS DEFENCE.

**In England:**

50. Training at home.

Chemical adviser for home forces, organizes all the anti-gas training.

The different gas departments are divided into various groups, such as: Eastern Command; Southern Command; Western Command.

Over each command is a chemical adviser, who conducts the school in that particular command.

Each command is divided up over nine areas; each area has a gas officer; each officer has a school for about nine days.

At each command school gas officers and non-coms are picked from the various areas.

Each Battalion has a gas officer or non-commissioned officer.

At the end of eight weeks the men try out their speed test, then a test at gas in gas chambers.

At the end of the eleventh week, men are trained to fit respirators (new ones).

At the end of the thirteenth week, a night attack.

The gas commander works with the bombing officer, to help make bombs.

Men have to fire while wearing their respirators (attacks, firing, living in them, marches).

**In France:**

Chemical adviser to Army.

Each army divided up into three corps.

One chemical adviser to each corps.

Each corps divided into three divisions.

Each Division has a gas officer.

Each Regiment has a gas officer.

Each Battalion a gas officer or non-commissioned officer. Army school trains gas officers for divisional army. Each division trains officers and non-commissioned officers.

**51. Officers are held responsible that all the anti-gas appliances for protecting their men are maintained in perfect condition, and that all ranks under their command are thoroughly trained in the use of these appliances and in all other measures which may affect their safety against gas.**

**52. Summary of Protective Measures.**

(a) Provision to each man of individual protective devices.

(b) Arrangement for the inspection of those appliances and training in their use and instruction in all other measures of gas defence.

(c) Provision of protected and gas-proof shelters.

(d) Weather observations to determine periods when the conditions are favorable to a hostile gas attack.

(e) Arrangement of signals and messages for immediate warning of a gas attack.

(f) Provision of appliances for clearing gas from trenches and shelters.

## ORGANIZATION OF ANTI-GAS DUTIES.

53. All ranks must be fully conversant with the measures to be adopted for defence against gas attacks as laid down in the Standing Orders of their formation or unit.*

A special **Gas Officer** is appointed in each Division so that technical advice is readily available on all matters connected with gas defence. This officer is also charged with all duties at the Divisional Anti-Gas School. Apart from this, the following scheme of anti-gas duties should be adopted within units.

## ANTI-GAS DUTIES WITHIN AN INFANTRY BATTALION.

(*To be modified for other units to suit their organization and duties.*)

54. The Commanding Officer will be directly responsible for all measures against gas attacks, and Company Commanders will be responsible to the C. O. for all anti-gas masures within their companies.

In each Company one N. C. O., who has been trained at an Anti-Gas School, and who has been recommended by the Divisional Gas Officer as suitable for duty as "Company Gas N. C. O.," will be specially detailed to assist the Company Commander in anti-gas measures. At least one other similarly trained and recommended N. C. O. will be immediately available to take the place of the Gas N. C. O. in case of need.

A similarly trained Gas N. C. O. will be detailed to Battalion H. Q. for duty with H. Q. details.

55. The special duties of the Gas N. C. O's. will be definitely laid down in Battalions.† Other duties may, however, be performed, provided that these do not interfere with the gas duties laid down.

56. In order to secure the necessary training in all matters pertaining to defense against gas attacks, the following officers and N. C. Os. should attend a course at the Divisional Anti-Gas School:

(a) **Officers.**

(1) The Commanding Officer or Second in Command and the medical officer.

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* For typical Divisional Standing Orders, see Chapter VII.

† For typical Standing Orders for Company Gas N.C.Os., see Chapter VIII.

(2) All Company Commanders.

(3) Other Officers and Warrant Officers, if and when possible.

(b) **N. C. Os.**

(1) Two per Company and per Battalion H. Q.

(2) Supplementary N. C. Os. to be trained whenever possible, so as to have a reserve from which to draw to replace Gas N. C. Os. in case of need.

The selected N. C. O's. who attend the Divisional Anti-Gas Schools will be reported on by the Divisional Gas Officer as follows: At the end of the course the Divisional Gas Officer will, if the N. C. O. is, in his opinion, suitable for duty as "Company Gas N. C. O.," notify the C. O. concerned to this effect. The latter will then cause the words "Passed Anti-Gas School" to be entered in his pay book. Only N. C. Os. who have been thus reported on favorably will be detailed for duty as Company Gas N. C. Os.

57. C. Os. will facilitate in every way the duties of the Divisional Gas Officer and his N. C. Os. in visiting their lines and inspecting anti-gas arrangements, testing Strombos horn cylinders, etc. They should take every opportunity of consulting with the Divisional Gas Officer on all technical questions relating to anti-gas measures within their lines.

## PERSONAL ANTI-GAS EQUIPMENT.

**Equipment Carried:**

58. Each man is provided with a small box respirator, a P. H. helmet and a pair of goggles. He must be made to realize that these appliances are **personal equipment, that they are of importance second only to his weapons, and that his life may depend on looking after them and keeping them in good order.**

59. The small box respirator is the most important protective apparatus. It is always to be used first in case of a gas attack, unless special orders are issued to the contrary. It will protect against all poisonous gases with the exception of mine and explosion gases, and will not become exhausted for hours, even in concentrations of gas normally unobtainable in the field.

60. The P. H. helmet is an emergency or reserve defense. It is only to be used if the owner should not have a box respirator or if the latter should be found, for any reason, to be defective.

The helmet protects against all poisonous gases used by the enemy, but it does not give complete protection against heavy bombardment by lachrymatory shells.

It is not possible to put the P. H. helmet on as quickly as the small box respirator.

61. The rubber-sponge goggles are intended for use in areas which have been subjected to a bombardment with lachrymatory shells, and in which the concentration of the lachrymator is so reduced that the air can be breathed without discomfort, though effect on the eyes remains. It must be remembered that after such a bombardment, the tear-producing effect may persist, even in the open, for several hours, and in trenches, dugouts, cellars, etc., may last for over a day.

**When and Where Carried:**

62. (*a*) All three appliances should be carried within three miles of the front line.

(*b*) When the wind is safe, working parties during work and at the discretion of the officer in command may take off their box respirators, provided the latter are placed conveniently at hand for use in case of a sudden gas shell attack or change of wind. The P. H. helmet will always be carried.

(*c*) At distances greater than three miles the P. H. helmet and goggles only need be carried, the box respirators being kept with the equipment under arrangements by the O. C. of the Unit.

## PROTECTION OF SHELTERS.

**Methods of Protection:**

63. Protection of dug-outs, cellars, buildings, etc., is given if all entrances are closed by well-fitting doors or by blankets sprayed with hypo. solution from a Vermorel sprayer. Practically no gas passes through a wet blanket, and the protection depends on getting a good joint at the sides and bottom of a doorway, so as to stop all draughts. This can be effected by letting the blanket rest on battens, fixed with a slight slope, against the door frame. The blanket should overlap the outer sides and a fold should lie on the ground at the bottom. A pole is fastened to the blanket, which allows the latter to be rolled up on the frame and causes it to fall evenly.

64. Wherever possible, particularly where there is likely to be movement in and out of the shelter, two blankets fitted in this

way but sloping in opposite directions should be provided. There should be an interval of at least 3 feet between the two frames, and the larger this vestibule is made, the more efficient is the dug-out.

When not in use, the blankets should be rolled up and held so that they can be readily released, and should be sprayed occasionally with water or a little Vermorel sprayer solution.

If the blankets become stiff from a deposit of chemicals, they should be sprayed with water.

65. All ranks must be taught how to use gas-proof dug-outs, *e. g.*, how to enter a protected doorway quickly, replacing the blanket immediately, and carrying in as little outside air as possible.

66. The protection afforded by these means is just as complete against lachrymatory gases as it is against cloud gas and poisonous shell gases.

**Shelters Which Should be Protected:**

67. The following should always be protected:

Medical aid-posts and advanced dressing stations, Company, Battalion and Brigade Headquarters, Signal Shelters and any other place where work has to be carried out during a gas attack.

In addition to the above, it is desirable to protect all dug-outs, cellars and buildings within the shell area, particularly those of artillery personnel. It should be noted, however, that the protection of dug-outs for troops in the front line of trenches is usually inadvisable on account of the delay involved in getting men out in time of attack. It is desirable to protect stretcher bearers' dug-outs with a view to putting casualties in them.

**Protection of Weapons and Equipment:**

68. Arms and ammunition and the metal parts of special equipment (*e. g.*, telephone instruments) must be carefully protected against gas by greasing them or keeping them completely covered. Otherwise, particularly in damp weather, they may rust or corrode so badly as to refuse to act. A mineral oil must be used for this purpose. The following in particular should be protected:

**Small Arms and Small Arms Ammunition:**

69. Machine guns and rifles must be kept carefully cleaned and well oiled. The effects of corrosion of ammunition are of even

more importance than the direct effects of gas upon machine guns and rifles.

Ammunition boxes must be kept closed. Vickers belts should be kept in their boxes until actually required for use. The wooden belt boxes are fairly gas-tight, but the metal belt boxes should be made gas-tight by inserting strips of flannelette in the joint between the lid and the box.

Lewis magazines should be kept in some form of box, the joints of which are made as gas-tight as possible with flannelette.

A recess should be made, high up in the parapet if possible, for storing ammunition and guns. A blanket curtain, moistened with water or Vermorel sprayer solution, will greatly assist in keeping the gas out.

**Hand and Rifle Grenades:**

70. Unboxed grenades should be kept covered as far as possible. All safety pins and working parts, especially those made of brass, should be kept oiled to prevent their setting from corrosion by the gas. In the case of No. 20 and No. 24 Rifle Grenades, oil should be worked in as much as possible under the sleeve retaining the studs, as these are liable to become set. The rods also require the same treatment.

**Light Trench Mortars and Their Ammunition:**

71. As far as the supply of oil permits, the bore and all bright parts of light trench mortars and their spare parts should be kept permanently oiled. When not in use, mortars should be covered with sacking or similar material.

Unboxed ammunition should be kept covered as far as possible and the bright parts oiled immediately after arrival. Ammunition which has been in store for some time should be used up first.

**Guns, Medium and Heavy Trench Mortars and Their Ammunition:**

72. The protection of artillery and artillery ammunition is dealt with in paragraph 156.

**Signals Equipment:**

73. The protection of signals equipment is dealt with in paragraph 163.

**Wind Observation:**

74. Officers detailed for that duty in all units in the front line report to Headquarters of Formations whenever the wind passes into a dangerous quarter, showing the direction and strength of the wind. As a result of these reports, "Gas Alert" is ordered by Corps or Divisional H. Q. These general reports, however, refer to large tracts of country and it is possible that on isolated lengths of front, conditions of terrain or the alignment of the trenches may permit of local air currents which are favorable to the enemy. It is essential, therefore, that the troops themselves should be on the lookout for the possibility of a gas attack. For this purpose Company Commanders are responsible that wind observations are made on their Company front every three hours, or oftener if the wind is in, or approaching, a dangerous quarter, and the reports forwarded through the usual channels to Brigade H. Q. For the method of making these observations and preparing the reports, see Appendix VI.

## THE GAS ALERT PERIOD.

**Order for Gas Alert:**

75. Gas Alert will be ordered when the wind is in the dangerous quarter, no matter what the strength of the wind.

The order "Gas Alert" will be sent out to all units by Corps H. Q. (or, if authority has been so delegated, by Divisional H. Q.), but Brigade H. Q. or Battalion Commanders are empowered to order a "Gas Alert" as a result of wind observations forwarded by Company Commanders. Such action will be reported immediately to the next higher formation.

Gas Alert notices should be posted at the entrance to each main communication trench and at other suitable points within Divisional Areas.

## PRECAUTIONS DURING GAS ALERT.

**Inspection:**

76. All box respirators and helmets should be carefully inspected and the inspection should be repeated daily. Steps must be taken to ascertain that all gas alarm appliances are in their position and in good order.

**Alert position of respirators and helmets:**

77. All ranks within one mile of the front line must carry their box respirators (or their helmets, should they have no box respirators) in the alert position. The press buttons of the flap of the box respirator satchel must be unfastened.

During Gas Alert the chin strap of the steel helmet must on no account be worn under the chin, as it will impede the rapid adjustment of the respirator or helmet.

**Special Orders for men using the P. H. Helmet:**

78. The two upper buttons of both jacket and greatcoat will be left undone. Men are forbidden to wear mackintosh sheets around their necks.

In no circumstances will anything (rifle, field glasses, etc.) be slung across the chest in such a manner as to interfere with the rapid adjustment of the helmet.

Jackets will not be taken off within one mile of the front line.

**Sentries, Etc.:**

79. A sentry should be posted at each strombos horn or other alarm device and instructed in its use and all working parties should have a sentry posted to give instant warning of a gas attack.

A sentry should be posted to every large shelter or group of small shelters and also to each Headquarters, Signal Office and each independent body of men.

Arrangements must be made by the officer in charge of the trench for warning the Artillery Observation Post if there is one in the trench.

Commanders of units in billets within 8 miles of the front line trenches must organize a system of giving the alarm and rousing all men in cellars or houses.

At night sentries should have at least two men within reach of them, so that the alarm can be spread rapidly.

**Sleeping:**

80. When a gas attack is probable, men in front line trenches should sleep on the fire step instead of in dug-outs. Men sleeping in rearward lines, or in works where they are allowed to take off their equipment, must sleep with their box respirators on the person.

**Company Gas N. C. Os.:**

81. Company Gas N. C. Os. will report to Company H. Q. in readiness to assist the Company Commander should a gas attack occur.

82. **Officers and N. C. Os. in command of any unit or party must see that the above orders are strictly carried out, both for troops in front line trenches and for detached bodies of troops (working and carrying parties, etc.)**

**Ammonia Capsules:**

83. Medical Officers must see that a proper proportion of the ammonia capsules are with stretcher barriers in the front line, in readiness for their immediate use after a gas attack.

**Removal of Gas Alert:**

84. Gas Alert will not be taken off without the authority of the Corps Commander or the Divisional Commander to whom authority has been delegated.

On the receipt of orders for the removal of Gas Alert, the notices on the subject will be amended accordingly.

## GAS ALARM.

**Method of Giving the Alarm:**

85.—For the purpose of giving the alarm the Strombos horn, which is audible for very long distances, is the most important appliance. Its main use is for conveying the alarm to troops in support and reserve lines. In addition some local appliance, such as a gong or suspended rail, must be fitted up at every sentry's post for the purpose of rousing the men in the immediate vicinity and for conveying the alarm to the sentries in charge of the Strombos horns.

Strombos horns should be in the front line, at intervals ordinarily not greater than 400 yards, and at such other points behind the front as required to ensure transmission of warning. As much use as possible should be made of the telephone for transmitting the gas alarm, though it cannot be relied upon owing to the possibility of its breaking down.

No reliance can be placed on methods of giving the alarm involving the use of the lungs, *e. g.*, bugles or whistles.

86. Sentries must be prepared to give the alarm on the first appearance of gas, as a few seconds delay may involve very serious consequences. Signals must be passed along by all sentries as soon as heard.

The earliest warning of a gas attack is given:—

(*a*) By the noise of the gas escaping from the sylinders.

(*b*) By the appearance of a cloud of any color over the enemy's trenches. If the attack takes place at night, the cloud will not be visible from a distance.

(*c*) By the smell of the gas in listening posts.

## ACTION TO BE TAKEN IN THE TRENCHES ON GAS ALARM.

87. (*a*) **Respirators** to be put on immediately by all ranks (a helmet, if no box respirator is available).

(*b*) **Rouse** all men in trenches, dug-outs and mine shafts, warn officers and artillery observation posts and all employed men.

(*c*) **Artillery Support** is to be called for by Company Commanders, by means of prearranged signals.

(*d*) **Warn** Battalion H. Q. and troops in rear.

(e) **All ranks stand to arms** in the front trenches and elsewhere where the tactical situation demands.

(*f*) **Blanket curtains** at entrances to protected shelters to be let down and carefully fixed.

(*g*) **Movement** to cease except where necessary.

## ACTION TO BE TAKEN IN BILLETS AND BACK AREAS.

88. (*a*) All men in cellars or houses to be roused.

(*b*) The blanket curtains of protected cellars, etc., to be let down and fixed in position.

(*c*) Box respirators to be put on immediately the gas is apparent.

## ACTION DURING A GAS ATTACK.

### PROTECTIVE MEASURES:

89. **There should be as little moving about and talking as possible in the trenches. Men must be made to realize that with the gas now used by the enemy, observance of this may be essential for their safety.**

When an attack is in progress, all bodies of troops or transport on the move should halt and all working parties cease work until the gas cloud has passed.

If a relief is going on, units should stand fast as far as possible until the gas cloud has passed.

Supports and parties bringing up bombs should only be moved up if the tactical situation demands it.

90. If troops in support or reserve lines of trenches remain in, or go into, dug-outs, they must continue to wear their anti-gas appliances.

Officers and N. C. Os. must on no account remove or open up the masks of the box respirators or raise their helmets to give orders. The breathing tube may be removed from the mouth when it is necessary to speak, but it must be replaced.

91. Men must always be on the lookout to help each other in case a box respirator or helmet is damaged by fire or accident. When a man is wounded, he must be watched to see that he does not remove his respirator or helmet until he is safely inside a protected shelter; if necessary, his hands should be tied.

Men must be warned that if they are slightly gassed before adjusting their respirators or helmets they must not remove them. The effect will wear off.

**Tactical Measures:**

92. From the point of view of protection against gas, nothing is gained by men remaining in unprotected dug-outs or by moving to a flank or to the rear. It is, therefore, desirable that on tactical and disciplinary grounds all men in the front line of trenches should be forbidden to do these things. In support or reserve lines, where there are protected dug-outs, it is advisable for men to stay in them unless the tactical situation makes it desirable for them to come out.

93. Nothing is gained by opening rapid rifle fire unless the enemy's infantry attacks. A slow rate of fire from rifles and occasional short bursts of fire from machine guns will lessen the chance of their jamming from the action of the gas and tends to occupy and steady the infantry.

94. It should be remembered that the enemy's infantry cannot attack while the gas discharge is in progress and is unlikely to do so for an appreciable time — at least 10 minutes — after it has ceased. It is, in fact, a common practice for the enemy infantry to retire to the second and third line of trench whilst gas is being discharged. There is, therefore, no object in opening an intense S. O. S. barrage of artillery on "No man's land"

during the actual gas cloud and it is advisable that the warning to the Artillery of a gas attack should be a signal differing from the ordinary S. O. S. signal, as the latter may have to be sent later if an infantry attack develops.

95. It must be remembered that smoke may be used by the enemy at the same time as, or alternately with, the gas and that under cover of a smoke cloud he may send out assaulting or raiding parties. A careful lookout must, therefore, be kept; hostile patrols or raiders may be frustrated by cross-fire of rifles and machine guns and should an assault develop the ordinary S. O. S. procedure should be carried out.

## PRECAUTIONS AGAINST GAS SHELLS.

96. Owing to the small explosion which occurs with these shells, they are liable to be mistaken for blinds, and even when the gas is smelt men may not realize its possibly dangerous character at once and so may delay putting on respirators or helmets until too late. Men sleeping in dug-outs may be seriously affected unless they are roused. Men in the open air are unlikely to be seriously affected by poison gas shells, provided they put on respirators or helmets on first experiencing the gas. The following points should therefore be attended to:

97. All shells which explode with a small detonation or appear to be blind should be regarded with particular attention; the respirator or helmet should be put on at the first indication of gas and blanket protection of shelters adjusted.

Arrangements must be made for giving a LOCAL alarm in the event of a sudden and intense bombardment with poison gas shells, but care must be taken that this alarm is not confused with the main alarm. Strombos horns must on no account be used to give warning of a gas shell bombardment.

All shelters in the vicinity of an area bombarded with poison gas shells must be visited and any sleeping men roused.

Box respirators or helmets should continue to be worn throughout the area bombarded with poison gas shells until the order is given by the local unit Commander for their removal.

98. Lachrymatory or "tear" shells are frequently used by the enemy for the purpose of hindering the movements of troops, for preventing the bringing up of supports, or for interfering with the action of artillery.

Owing to the deadly nature of poison gas shells, however, **the precautions given in paragraph 97 above must be taken for all gas shells.** The goggles are intended for use after *lachrymatory* bombardments only, in cases where the irritant gas persists in the neighborhood of shell holes, etc.

## PRECAUTIONS TO BE TAKEN WITH REGARD TO OUR OWN USE OF GAS IN CYLINDERS, BOMBS, ETC.

99. Protection of troops is necessary during our own gas attacks. Adequate protective measures should always be possible, as arrangements can be made in advance and the element of surprise can be excluded. The following points should be noted:

### Handling Gas Cylinders:

100. Men engaged in carrying or digging-in gas cylinders should carry their box respirators in the "Alert" position.

### Action When Gas Cylinders Are in Position in Trenches:

101. (*a*) Box respirators should be carried in the "Alert" position by troops in front line trenches.

(*b*) If a cylinder is burst by shell-fire, men should retire upwind for a short distance if possible. Dug-outs in the neighborhood of the burst must be evacuated at once.

### Action During Our Gas Attacks:

102. (*a*) It is advisable that all troops, except those whose presence is considered absolutely necessary, should be withdrawn from the front trench before gas is discharged Any officer or man who has special orders to remain must *wear* his box respirator.

(*b*) All troops in any part of the line within half a mile of the nearest point where gas is being discharged must *wear* their box respirators.

(*c*) If troops advance after a cloud gas attack has been made, it must be remembered that the gas may hang about for a considerable time in long grass, shell holes and hollows, and for several hours in the enemy's shelters. Raiding or reconnoitring parties after a gas discharge should carry their respirators in the Alert position. Dug-outs should not be occupied until they have been thoroughly ventilated and the absence of gas established.

This is equally necessary with regard to shelters which have been penetrated by gas from shells or bombs.

Gas Bombs and Grenades:

103. These may, if necessary, be stored with other ammunition. In the event of leakage they should be buried in the ground 3½ feet deep. They should not be thrown into water. All rescue work and disposal of leaky shells should be carried out by men wearing box respirators.

## ACTION SUBEQUENT TO A GAS ATTACK.

General:

104. **The most important measure to be taken after a cloud gas attack is to prepare for a further attack.** The enemy frequently sends several successive waves of gas at intervals varying from a few minutes up to several hours and it is therefore necessary to be on the alert to combat this procedure. The following measures should be adopted as soon as the gas cloud has passed:

(*a*) **Removal of respirators.**—Anti-gas fans should be used to assist in clearing the trenches of gas, so as to admit of respirators being removed. Box respirators and helmets must not be removed until permission has been given by the Company Commander, who will, when possible, ascertain from officers and N.C.O's. who have been trained at a Divisional Gas School that it is safe to do so.

(*b*) **Return to the Alert position.**—So as to be ready for a subsequent attack, box respirators and helmets must be put back in the Alert position.

A sharp look-out must be kept for a repetition of the gas attack, as long as the wind continues in a dangerous quarter.

Movement:

105. Owing to the enemy gas sometimes causing bad after-effects, which are intensified by subsequent exertion, the following points should be attended to:

(*a*) No man suffering from the effects of gas, however slightly, should be allowed to walk to the dressing station.

(*b*) The clearing of the trenches and dug-outs should not be carried out by men who have been affected by the gas.

(*c*) After a gas attack, troops in the front trenches should be relieved of all fatigue and carrying work for 24 hours by sending up working parties from companies in rear.

(*d*) Horses which have been exposed to the gas should not be worked for 24 hours if it can be avoided.

**Clearing Dug-outs and Other Shelters:**

106. It is essential that no dug-out be entered after a gas attack, except with box respirators or helmets adjusted, until it has been ascertained that it is free from gas. The only efficient method of clearing dug-outs from gas is by thorough ventilation. The older method of spraying is not efficient.

An appreciable quantity of gas may be retained in the clothing of men exposed to gas attacks and also in bedding, coats, etc., left in shelters. Precautions should, therefore, be taken to air all clothing.

**Ventilation:**

107. **Natural Ventilation.**— Unless a shelter has been thoroughly ventilated by artificial means, as described below, it must not be slept in, or occupied without wearing respirators, until at least 12 hours have elapsed. It must not be entered at all without respirators on for at least 3 hours. The above refers to cloud gas attacks. In the case of gas shell bombardments the times cannot be definitely stated, as they depend on the nature of the gas used and the severity of the bombardment. With lachrymatory gases the times after which shelters can be used without discomfort may be considerably longer than those mentioned above.

108. **Ventilation by Fire.**—All kinds of shelters can be efficiently and rapidly cleared of gas by the use of fires. Shelters with two openings are the easiest to ventilate and where possible dug-outs with only one entrance should have a second opening made, even a very small one, to assist in ventilation.

In dug-outs provided with a single exit at the end of a short passage the best results are obtained if the fire is placed in the centre of the floor of the dug-out and at a height of about 6 inches.

In dug-outs provided with a single exit at the end of a long and nearly horizontal passage the best results are obtained if the fire is placed about one-third of the distance from the inner end of the passage.

In dug-outs provided with two or more exits the fire should be placed at the inner end of one of the exit passages.

109. In general, 1 lb. of dry wood per 200 cubic feet of air space is sufficient for clearance of any gas. The best fuel is split wood, but any fuel which does not smoulder or give off thick smoke can be used. The materials for the fire, *e. g.*, the split wood, newspaper, and a small bottle of paraffin for lighting purposes, should be kept in a sandbag enclosed in a biscuit tin provided with a lid. An improvised brazier should be kept ready for use.

The fire must be kept burning for at least ten minutes and the atmosphere in the shelter should be tested from time to time.

110. **Ventilation by Fanning.**—Dug-outs can be ventilated by producing air currents in them by means of special anti-gas fans. A full description of the anti-gas fan and the method of using it to clear gas from trenches and shelters is given later (see paragraphs 102-106).

If no anti-gas fans are available, ventilation can be assisted by flapping with improvised fans such as sandbags, ground sheets, etc.

**Sprayers:**

111. The use of Vermorel sprayers for clearing gas from trenches and shelters has been given up. The hypo. solution has very little effect on phosgene and even with the addition of other chemicals it cannot be relied upon to remove this gas from the air. Vermorel sprayers have consequently been withdrawn from general use.

**Cleaning of Arms and Ammunition.**

112. Rifles and machine guns must be cleaned after a gas attack and then re-oiled. Oil cleaning will prevent corrosion for 12 hours or more, but the first available opportunity must be taken to dismantle machine guns and clean all parts in boiling water containing a little soda. If this is not done, corrosion continues slowly even after oil cleaning and may ultimately put the gun out of action.

After a gas attack, S. A. A. should be carefully examined. All rounds affected by gas must be replaced by new cartridges immediately and the old ones cleaned and expended as soon as possible.

113. All hand and rifle grenades exposed to the gas should have their safety-pins and working parts cleaned and reoiled.

114. All bright parts of light trench mortars, together with all accessories and spare parts exposed to the gas, must be cleaned and wiped dry as soon as possible after the attack and in any case within 24 hours, after which they should be thoroughly coated afresh with oil. The same applies to ammunition which may have been exposed to the gas.

Ammunition which, for any reason, had not been oiled, must be cleaned and oiled and expended as soon as possible.

For details regarding the cleaning of guns and artillery ammunition and signal equipment, see paragraphs 156 and 163.

### Treatment of Shell Holes:

115. In the neighborhood of shelters or battery positions where gas from shell holes is causing annoyance, the holes and the ground round them should be covered with at least a foot of fresh earth. Shell holes so treated should not be disturbed, as the chemical is not thereby destroyed and only disappears slowly.

## PART III.—PROTECTIVE APPLIANCES.

## INDIVIDUAL PROTECTIVE APPLIANCES.

### Box Respirator:

#### Description:

116. The box respirator consists of a box packed with chemicals and connected by means of a flexible rubber tube to an impervious face-piece or mask. The inspired air enters through a valve in the bottom of the box; the expired air is expelled through a valve just outside the face-piece. The wearer breathes in and out through a mouthpiece inside the mask, breathing through the nose being prevented by a nose-clip inserted in the face-piece. The latter is made of gas-proof fabric and is arranged to fit the face closely, being held in position by two elastic bands. As it encloses the eyes, the mask is fitted with two eyepieces which follow a wide field of vision. These should be treated with anti-dimming composition, but if necessary they can be cleaned

without removing the respirator, by means of folds in the material. The mouthpiece can be removed from the mouth to enable the wearer to speak, without disturbng the fit of the mask. The complete respirator is carried in a special satchel which is divided into two compartments, one of which holds the box and the other the mask. The box rests on a metal saddle which raises it from the bottom of the satchel and allows the free access of air.

### Personal Fitting:

117. It is necessary that each man should have a box respirator, the mask of which fits his face properly. For this reason the face-pieces are made in four sizes, which are issued in the following proportions:

No. 1. Extra small. Only issued on special indent.
No. 2. Small. 10 per cent.
No. 3. Medium. 80 per cent.
No. 4. Large. 10 per cent.

The fit of each man's mask must be inspected and then tested in a gas chamber. Almost any room which can be closed up tightly may be used for this purpose, but the most suitable arrangement is to have a double door or a door and a curtain similar to the protected dug-outs, so that as little of the gas as possible escapes into the outer air. A still better arrangement is to use two adjoining rooms, the inner of which is the actual gas chamber. A small quantity of lachrymatory liquid is sprayed into the room, and the man enters, wearing his box respirator. He must remain in the room five minutes and move about and talk. If the mask does not fit, lachrymation quickly ensues and the man retires. He should then be examined to see whether the lack of fit is due to bad adjustment or to his having a wrong size of mask. In the latter case a different size must be issued and the test repeated.

The fitting and adusting of the mask cannot be too thoroughly carried out. Special attention must be paid to the fitting of the mask and nose-clip with men who wear spectacles.

### Method of Use:

118. The satchel containing the box respirator is carried outside all other equipment. When away from the trenches, it may be worn slung over the right shoulder, but men in the trenches

or proceeding thither must carry it slung on the chest as in the "Alert" position. The flap of the satchel with the press butttons must always be toward the body, but the press buttons must be kept fastened, except during an actual "Gas Alert." The method of wearing the box respirator and of putting it on from the "Alert" position are fully described in Chapter IV. It is important that the methods therein described should be practiced by all who are equipped with the box respirator, to insure rapidity in adjustment and proper care in its use.

119. Men with perforated ear drums may be affected by the gas penetrating through the ear passages to the respiratory organs and causing irritation there. In these cases it is useful to plug the ears with wadding. C. Os. should ascertain from the Medical Officers in charge of the units the names of those suffering from this disability in order that the above precaution may be taken.

120. It mst be remembered that the box respirator can be worn in gas for many hours on end without losing its efficiency or causing any distress. It may be breathed through in drills for a period of a quarter of an hour per week for an indefinite time without impairing it efficiency. This permits a drill period of at least an hour per week. This is in addition to the initial drills referred to in Chapter IV., amounting to 1 1-2 hours' breathing through the box.

**Replacement. Record of Use:**

121. The correct keeping of records as to hours of use of the box respirator, by entries in the small book forming part of the repair outfit, is a matter of the greatest importance, as these records form the only guide as to whether the boxes should or should not be replaced. Decision as to replacement should be made on the advice of the Divisional Gas Officer. The approximate time of actually breathing through the box should be noted. These entries must always be made after drills and gas attacks, great care being taken that they are correct.

**Inspection:**

122. Box respirators must normally be inspected once a week and daily during "Gas Alert."

**It is of the utmost importance that the inspection should be carried out regularly and with the greatest care. Any neglect in doing this may lead to loss of life.**

The points to be attended to will be found in Appendix II.

**Anti-Dimming Composition:**

123. At the weekly inspection and after every time the respirator is worn, the composition provided for the purpose will be put on the eyepieces in the manner described in Chapter V, Par. 172.

**Local Repairs:**

124. A small repair outfit, consisting of pieces of adhesive plaster is included, with a record card, in each satchel.

Small perforations in the face-pieces can be made good by applying pieces of the adhesive plaster to the perforation, both inside and outside the mask. They should be large enough to overlap the hole all round. Box respirators so repaired should be exchanged as soon as possible. The repair is only intended to make them safe until a new respirator can be obtained.

No other local repairs are permitted and all defective respirators must be handed in and new ones obtained.

Box respirators which have fallen into water must be exchanged as soon as possible.

## P. H. HELMET.

**General:**

125. The P. H. helmet is the reserve defense against a gas attack and great care must be taken by officers to ensure that it is in good order and that the men have been trained in its use. The main point to impress on them is that the chemically-treated material acts as a filter and that all air breathed into the lungs must pass through the flannelette. The helmet is, therefore, useless unless properly tucked in under the jacket. During its passage through the material of the helmet all poisonous gas is absorbed by the chemicals. These chemicals, however, would be gradually destroyed by the breath or by undue exposure to the air, and the helmet is, therefore, provided with a valve to breathe out through. The helmet should not be exposed unnecessarily to the air. It must be kept from exposure and wet and only removed from the wallet for inspection and drill.

**Method of Use:**

126. When the box-respirator is worn the P. H. helmet should hang perpendicularly downwards from the left shoulder, the sling passing under the belt. It must be over all other equipment. Care is necessary in folding it properly in the wallet in such a manner that the valve and eye-pieces are not damaged and that it can be put on in the quickest possible time. The method of folding is described in Chapter V.

127. If, for any reason, a man has to rely on a P. H. helmet for his anti-gas protection, he should wear it during "Gas Alert" periods in the manner prescribed in Chapter IV. All equipment should be adjusted so that nothing interferes with the rapid putting on of the helmet.

**Drill:**

128. **Helmet drill should be carried out frequently by all ranks.** It should aim at teaching the quick adjustment of helmets under all conditions, accustoming men to wearing them for a long time and taking exercise in them. Drill must be carried out both with and without greatcoats and equipment and by night as well as by day. The points to be attended to in helmet drill are specified in Chapter IV.

**Inspection of Helmets:**

129. Helmets must be inspected once a week and daily during "Gas Alert." **It is of the utmost importance that this inspection should be carried out regularly and with the greatest care. Any neglect in doing this may lead to loss of life.** The points to be attended to will be found in Chapter V.

**Replacement and Repair:**

130. Helmets will be withdrawn as follows:

(1) Immediately after a cloud gas attack.

(2) After being worn for a total period of 24 hours in gas shell bombardments, false gas attacks or drill.

(3) After being carried for 28 days in the "Alert" position.

Slight defects, such as the cross-threading of eye-pieces, should be rectified locally with the help of the Company Gas N.C.O. Helmets the defects of which cannot immediately be rectified must be condemned.

Anti-Gas Goggles:

131. Goggles for use against lachrymatory gas will be carried in the helmet satchel by all ranks. They will be inspected weekly, and treated with anti-dimming composition, in the manner described in Chapter V.

Horse Respirators:

132. A full description of the Horse Respirator and the method of using it is given in Chapter VI.

## B.—ANTI-GAS APPLIANCES FOR GENERAL USE.

Strombos Horns:

General:

133. The experience gained in recent gas attacks has shown that Strombos Horns are the most effective form of gas alarm appliance and are audible for very long distances.

Description:

134. Each horn is issued in a box containing one horn, two compressed-air cylinders, one length of rubber tubing with screw connections, one screwdriver, one gimlet and one adjustable spanner. One spare cylinder is issued with the horn, to be kept at the Divisional or Brigade H.Q. to replace used cylinders without delay A reserve of charged cylinders is also kept at the Heavy Mobile Workshop.

Method of Use:

135. The horn should be mounted in a horizontal position by screwing to the outside of the case or to some other suitable support and must be protected as much as possible from rain or shell splinters. Should it be necessary to change its position, the horn should be fixed in the box by means of the butterfly nuts provided. Strombos horns must always be ready for use, the horn being connected to one of the compressed-air cylinders by the rubber tube. The union joints at both ends of the tube must be tight.

136. To sound the horn, unscrew the screw cap on the air cylinder two complete turns. The horn will sound for about one minute.

Immediately after use, couple up the horn to the second air cylinder and leave it ready for use in case of a second gas cloud. The used cylinder should be clearly marked EMPTY and replaced as soon as possible from the reserve.

### Replacement and Repair:

137. The pressure of the cylinders will be tested under arrangements made by the Divisional Gas Officer once every week and defective ones returned through D.A.D.O.S. for recharging at the Heavy Mobile Workshop.

On no account is any adjustment of the horn to be attempted except by the Divisional Gas Officer or his trained Divisional Gas N.C.O's. A horn will be thrown completely out of action by movement of any of its parts.

Damaged horns must be sent to the Army Heavy Mobile Workshop for repairs.

### Other Gas Alarm Devices:

138. No definite pattern has been adopted for secondary alarm devices suitable for installing at every sentry post. Bells, gongs (shell cases), suspended rails and other appliances are all in use, but single bells and gongs are generally too weak and all these arrangements suffer from requiring the use of a man's hands.

A very suitable arrangement as an alarm is a triangle of light steel rail, mounted in such a way that it can be beaten by working a treadle. It can thus be sounded by a sentry while he is putting on his respirator or helmet. Similar devices not requiring the use of the hands should be devised and installed where feet long.

### Anti-Gas Fans:

139. The Anti-Gas Fan consists of a sheet of canvass supported by braces of cane and reinforced in the middle. It is made with two transverse hinges and is fitted with a hickory handle. The flapping portion is roughly 15 inches square and the handle is 2 long.

## METHOD OF USE.

### Clearing Trenches:

140. The fan blade is placed on the ground with the brace side *downwards*, the man using it being in a slightly crouching position

with the left foot advanced, the right hand grasping the handle at the neck and the left hand near the butt end. The fan is brought up quickly over the right shoulder, and then smartly flicked to the ground with quick slapping strokes. This drives a current of air along the earth and, on the top strokes, throws the gas out of the trench as it were by a shovel.

It is essential that the part of the fan blade nearest the handle should touch the ground first, and this can be accomplished in all cases by ending the stroke with the whole length of the handle as close to the ground as possible.

141. In working round a traverse, etc., the fan should be flapped round the corner with the hinge on the corner and the lower edge of the fan as near the bottom of the trench as can be managed. The brace side of the fan is to be outwards and at the end of the stroke the whole length of the handle should be close up to the side of the trench.

If several fans are available, men should work in single file and with "out-of-step" strokes, *i. e.*, one fan should be up while the next is down.

**Clearing Shelters:**

142. In the case of a dug-out with a single entrance not exceeding 12 feet in length, the gas is first cleared from the neighborhood of the shelter as in 103 and then the corners worked round as in 104. The worker now advances to the inner end of the entrance, beating rather slowly on the ground to allow the gas time to get out of the tunnel and bringing the fan as near the roof as possible on the return stroke.

It may be desirable to have a second fan working just outside the dug-out to throw the gas out of the trench as it comes out.

143. In the case of dug-outs with two entrances or with one entrance and another opening, such as a chimney, it is only necessary to use the fan round the corner of one entrance in the manner described in 141. When the entrance is cleared, it is advisable to enter the shelter with a respirator on in order to beat up the gas from the floor boards, etc. This greatly facilitates the removal of the last traces of gas.

**Vermorel Sprayers:**

144. Vermorel sprayers are withdrawn from general use for clearing out gas after an attack, but a certain number are re-

tained for moistening the blankets of protected shelters and for use in medical dug-outs, etc. They should be kept for this purpose only and on no account relied on for clearing trenches or shelters of gas.

145. **Company Vermorel Sprayers.**—Sprayers on the basis of two per Company are retained for moistening blanket protection. They should be kept by Company Gas N. C. O's. with other anti-gas trench stores, and should be kept one-third full of water. The solution must be kept in corked rum jars or other closed receptacles close to each sprayer; it must not be kept in the sprayers owing to its corrosive nature. It is made up as follows:

Water, 3 gallons (one large bucket).
Sodium Thiosulphate (hypo.), 1½ lbs. (¾ mess-tin).
Sodium Carbonate (washing soda), 3 lbs. (1½ mess-tins).

Three rum jars are required to hold the above quantity and the necessity for keeping them corked must be impressed on the personnel responsible for it.

When no solution is obtainable, water may be used for spraying the blankets.

**Gas Sampling Apparatus:**

146. It is very desirable that samples be obtained of the enemy gas used in attacks, especially cloud gas attacks. For this purpose two kinds of appliances are kept in the trenches, viz.: Vacuum Bulbs and Gas-testing Tubes. These should be looked after by the Company Gas N.C.O's, whose duty it is to take the samples, but officers should take all possible steps to ensure that samples of the gas are actually taken, as the information obtained may be of the greatest importance.

Full details of the methods of taking samples are laid down in "Standing Orders for Company Gas N. C. O's." (Chapter X.)

## PART 4.

## CONSIDERATIONS AFFECTING SPECIAL ARMS.

147. The foregoing notes apply to all arms and are complete as regards considerations of gas defense affecting troops in trenches generally. Additional information for the guidance of other arms on anti-gas measures which affect them specially is given below.

## CAVALRY.

148. It is unlikely that Cavalry, when mounted, will encounter high concentrations of gas from a gas cloud, or even from gas shells. It will probably be found therefore that, when acting as mounted troops, the P. H. helmet will be adequate protection, besides being less cumbersome for troops depending on their mobility.

149. On the other hand, Cavalry used to supplement Infantry in the line, or employed as working parties in or near the trenches, must be equipped for gas defense in the same way as other arms. In this case, it is impossible to wear the bandolier over the shoulder when the box respirator is worn in the "Alert" position. During the Gas Alert period, mounted troops must therefore wear the bandolier round the waist. This can be accomplished as follows (Fig. 1):

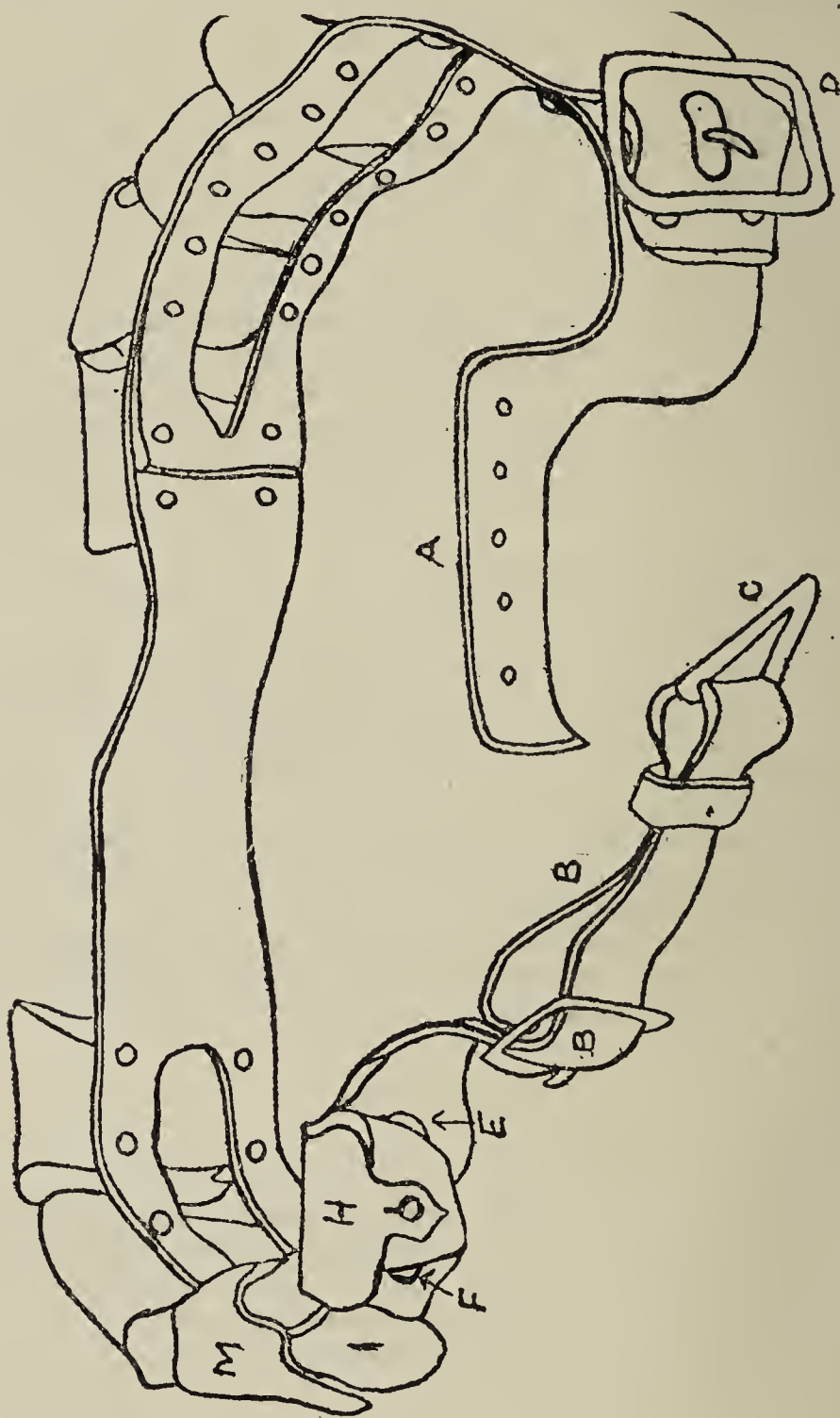
150. (1) Unfasten the buckle D.
(2) Pull out strap A from the metal triangle C.
(3) Pass the bandolier round the waist.
(4) Pass strap A from behind forwards through the aperture E, situated under pouch H. (This aperture may have to be slightly enlarged.)
(5) Pull on strap A until the bandolier fits and buckle off to D.
(6) Strap B1, with the attached buckle B, and triangle C, can now be tucked away under the bandolier to the right, behind pouches H and M.
(7) For thin subjects, it may be better to pass strap A through the aperture F between pouches H and M before buckling it off to D, so as to make the bandolier tighter.

## ARTILLERY.

General:

151. Artillery are probably more liable than anyone else to bombardment with gas shells, both poisonous and lachrymatory. Owing to the suddenness of shell attacks and the long period that the neighborhood of a battery may be affected by lachrymators, it is essential that the following points be noted:

(*a*) Where, owing to circumstances, box respirators are not actually worn on the man, they must be hung sepa-


D
A
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B
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rately and within easy reach of the owners. (They should not, if possible, be hung in the actual gun emplacements, owing to the concussion being liable to displace the chemicals in the box.) If this course has to be adopted, the respirators should be ready prepared with the haversack sling shortened by means of the tab and stud and the slack of the sling tucked under the mask as in the "Alert" position. The satchel flap should be unbuttoned, but kept in position.

Men must be thoroughly practiced in getting their respirators on in the shortest possible time when they are stored in this manner.

The P. H. helmet will, in any case, always be carried on the man in case of emergency.

(*b*) Men must be well practiced in wearing their box respirators for long periods and in serving their guns while wearing respirators or anti-gas goggles.

152. Omitted on account of being obsolete.

153. Omitted on account of being obsolete.

154. Omitted on account of being obsolete.

**Forward Observing Parties:**

155. Forward observing parties must take all the precautions previously laid down for Infantry.

**Preservation of Guns and Ammunition:**

156. The following precautions apply to medium and heavy trench mortars as well as to guns and howitzers:

**Protection:**

Batteries which are in constant danger of gas attacks, whether from gas clouds or gas shells, should keep all bright parts of the gun or mortar, carriage, mounting and accessories well coated with oil.

Sights and all instruments should also be smeared with oil and protected with covers when not in actual use, care being taken that the oil does not come in contact with any glass or find its way into the interior of the instrument.

Cartridge cases of the ammunition stored with the Battery and all uncapped fuses, or fuses which have been removed from their cylinders, should be wiped over with oil as soon as possible and protected with a cover.

**Cleaning:**

All bright parts of guns and trench mortars, together with all accessories and spare parts exposed to the gas, must be cleaned and wiped dry as soon as possible after the attack, and in any case within 24 hours, after which they should be thoroughly coated afresh with oil.

The same applies to the whole of the ammunition still in the Battery position. Ammunition which, for any reason, had not been oiled, must be cleaned and oiled. It is desirable to expend it as soon as possible.

**Aiming Points and Aiming Posts:**

157. Aiming points and aiming posts are liable to be obscured by the gas cloud and arrangements should, therefore, be made in every Battery to meet this eventuality by providing gun pits with means to check the line of fire if necessary, without depending on the use of aiming posts.

**Tactical Measures During a Gas Attack:**

158. Enemy gas attacks may be executed for purposes other than the preparation of a subsequent infantry attack. During the gas discharge a heavy artillery fire on the actual trenches whence the gas is issuing is the best way of dealing with the situation. Also it is essential that the gas discharge should be interfered with as early as possible, as the opening periods of the discharge are the most effective.

159. To insure an effective and immediate artillery fire the following points require attention :—

(*a*) Certain howitzer Batteries should be detailed to open a rapid fire for a short time as an anti-gas measure.

(*b*) Only certain portions of the enemy's front trenches can be used for gas discharge in any given wind and these can easily be indicated on any accurate trench map. Each Battery charged with the task of hampering an enemy gas attack should be provided with a map and a table,

*Photo from Underwood & Underwood, N. Y.*

RESPIRATOR DRILL FOR THE MEN GOING INTO THE TRENCHES.

This photograph shows a squad of the British Guards at respirator drill before going into the trenches. The men who are taking part in the great British offensive on the Western front go through this drill both before and after leaving the trenches.

showing from what portions of the enemy's lines (within the Battery's zone of action) gas can be discharged in any given wind.

160. Nothing in the foregoing paragraphs in any way affects the responsibility of artillery for dealing with any infantry attack, or for the execution of counter-battery work.

## (C).—TUNNELING COMPANIES.

161. (i) Tunneling companies are again reminded that neither the box respirator nor the P. H. helmet affords protection against mine or explosion gases.

(ii) Owing to the difficulty in clearing gas, especially lachrymatory gas, from mine-shafts and galleries, the entrances to mine-shafts should be protected from gas by blanket curtains in the manner already described for dug-outs.

(iii) The enemy has occasionally attempted to render our galleries untenable by the use of lachrymatory bombs in conjunction with the explosion of a charge. If this is done, goggles will generally be found sufficient protection; but if the concentration is so high as to affect the nose or lungs, the box respirator must be worn if work has to be continued.

## SIGNAL SERVICE AND TELEPHONE OPERATORS.

**General:**

162. It is essential that telephone operators should be able to work as much as possible during a gas attack without wearing respirators or helmets. Signal dug-outs must, therefore, be particularly carefully protected against gas, so as to allow this to be done.

Telephone operators must be specially practiced in using their instruments when wearing box respirators or helmets. The headpiece of the receiver will be worn over the helmet. The buzzer should be used when the respirator or helmet is worn.

Linesmen must receive plenty of practice in carrying on their work, both at night and in the daytime, while wearing box respirators and also goggles.

## PRESERVATION OF SIGNAL EQUIPMENT.

**Protection of Telephone Instruments:**

163. The only effective method of preventing corrosion of electrical apparatus during a gas attack is to prevent the gas reaching it, and the best way of doing this is to have Signal Shelters and Offices thoroughly protected against gas. As the

corrosive effect on damp instruments is very much greater than on dry instruments, the shelters should be kept as dry as possible.

During a gas attack, D. Mk. III. telephones must be kept in their leather cases and unless the buzzer key is being used the leather flap must be kept down, leaving only the cords with receiver and hand-set out of the case. The backs of switchboards and buzzer exchanges must be kept closed. All apparatus, such as magneto telephones, test boards, spare instruments, etc., which it is not essential to have uncovered should be well covered up with cloths, blankets or coats, etc.

**Cleaning Instruments After a Gas Attack:**

164. After a gas attack, telephone apparatus that has been exposed to gas should be treated as follows:—

The ends of the wires should be removed from terminals and cleaned by being scraped with a knife, wiped with a damp cloth and dried. Terminals, exchange plugs and all exposed metal work should be cleaned first with a damp and then with a dry cloth. This process should be repeated after 12 hours have elapsed. The metal work of the leather case of the D. Mk. III. telephone and of other instrument cases should be cleaned with oil in the same way as rifles, etc. The internal portions of the instruments should not be interfered with. If an instrument has been kept closed or covered up, it is very unlikely that internal portions will have suffered; but if these portions show signs of corrosion, the instruments should be sent back to Division or Corps Headquarters to be dealt with by an Instrument Repairer.

**Protection of Carrier Pigeons:**

165. When the gas alarm is sounded, all baskets containing pigeons should be placed in the special Anti-Gas Bags provided for this purpose, or placed in gas-proof shelters. If for any reason the birds cannot be protected from the gas, they should be liberated at once. Anti-gas bags should always be kept near baskets containing birds, and should be regularly inspected.

Pigeons can be utilized during a gas attack. Experience has proved that they will fly through any gas cloud, but it is imperative that the bird should be exposed to the gas for as short a time as possible. The message and carrier should, therefore, be prepared and if possible, fastened to the pigeon's leg, before the bird is exposed to the gas. Twenty seconds should suffice to fix a carrier and liberate a bird.

# CHAPTER IV.

## DRILLS WITH BOX RESPIRATORS AND HELMETS.

### Part 1.— Practice A, B, C, D, E, F, G, H.

**Practice "A":**

166. Adjustment of the Box Respirator in the "Alert" position.

Hang the box respirator round the neck with the press buttons next the body. With the right hand seize the satchel by the leather tab, with the left hand seize the sling by the brass button and clip this into the leather tab. Undo the press buttons, closing the satchel.

The length of whipcord will then be withdrawn from the right-hand compartment, passed through the ring on the right of the satchel and carried round the waist to the ring on the left, where it is fastened The press buttons closing the satchel will be left undone, but the flap will be put in position to keep the respirator from wet.

**Practice "B":**

Drill "by numbers" to obtain correct adjustment of the Box Respirator.

NOTE.— This drill is to be carried out alternately with one "judging the time," *i. e.*, as quick adjustment as possible. It is the most important and complete adjustment must be obtained by all ranks in SIX SECONDS.

Adjust the respirator in the alert position with satchel covered but not buttoned.

1. On the command "One" place the left hand on the cheek and knock off steel helmet on to left wrist from behind with the right hand, press down both thumbs between the satchel and the body and open the satchel flap. Immediately seize the mask with the right hand, the metal elbow tube just outside the mask being in the palm of the hand and the thumb and first finger grasping the wire frame of the nose clip.

2. On the command "Two" bring the mask smartly out of the satchel and hold it in both hands with all the fingers outside round the binding and the two thumbs inside, pointing inwards and upwards under the elastic. At the same time *throw the chin well forward* ready to enter the mask opposite the nose clip.

3. On the command "Three" bring the mask forward, digging the chin into it and with the same motion bringing the elastic bands back over the crown of the head to the full extent of the retaining tape, using the thumbs.

4. On the command "Four" seize the metal elbow tube outside the mask, thumb on the right, fingers on the left — all pointing towards the face. Push the rubber mouthpiece well into the mouth and pull it forward until the rim of the mouthpiece lies between the teeth and the lips and the two rubber grips are held by the teeth.

5. On the command "Five" adjust the nose clip to the nose, using the thumb and first three fingers of the right hand. Run the fingers round the mask on either side of the face to make sure that the edges are not folded over. Correct any faults in adjustment. Come smartly to attention.

Practice "C":

To adjust Box Respirators when carried over the shoulder and not in Alert position.

Sling the satchel round so that it hangs in front of the body. Undo the press buttons and adjust the mask as in Practice "B," allowing the satchel to hang by the rubber tube.

After the nose clip is put on, at once proceed to adjust the satchel in the Alert position, as in practice "A."

Practice "D":

Drill to teach cleaning of eyepieces.

On the command "Clean Eyepieces" the right eyepiece will be gripped between the thumb and first finger of the left hand. The first finger of the right hand will then be pushed gently into the fold of the mask behind the right eyepiece which will be cleaned with a gentle circular motion.

The left eyepiece will be cleaned in a similar way.

Practice "E":

Drill to teach method of giving orders.

It is first explained to a squad that the nose clip must not be removed to talk and that before each sentence is spoken a long breath must be taken and the mouthpiece removed sideways from

the mouth by turning the metal tube outside the mask to one side. After speaking, the mouthpiece is replaced.

The squad should then be numbered off, extended to four paces, and orders passed along the line.

Officers and N.C.Os. will receive special care in Practice "E."

**Practice "F":**

Drill to teach method of clearing mask from gas which may have leaked in and is affecting the eyes.

Press the mask close to the face, forcing out foul air round the sides and then fill again with fresh air from the lungs by blowing out round the mouthpiece.

**Practice "G":**

Drill to teach method of testing whether trench or dugout is free from gas.

With the right hand open the facepiece away from the right cheek, then loosen the nose clip on the nose and smell gently (do not take a breath). If gas is smelt, the nose clip and mask are replaced. Then as in Drill "F" if no gas is smelled, left hand is removed from nose clip and placed under facepiece on left cheek. Mask is then removed with both hands.

**Practice "H":**

Ordinary infantry drill will be carried out while wearing the mask. This will include doubling for at least 200 yards at a time. Marching order will be worn. Musketry and bombing instruction and training of specialists (including artillery, machine gunners, signallers, medical corps) will also be carried out.

## PART 2.—TUBE HELMET DRILL.

**166-A.** Helmet drill should be carried out frequently by all ranks. It should aim at teaching the quick adjustment of helmets under all conditions, accustoming men to wearing them for a long time and taking exercise in them. Drill must be carried out both with and without greatcoats and equipment and by night as well as by day.

Men may use their own helmets for drill purposes. Tube helmets which have been worn for 24 hours for drill will be replaced.

The following points are to be noted:

(i) Men must be timed against a watch in removing the helmet from its wallet getting it over the head and gripped at the neck with one hand so that the material is tight all around. This should take less than 6 seconds and the importance of continual carrying out of this practice cannot be too strongly emphasized. Men should be taught to **hold the breath** while putting on the helmet, as a few breaths drawn in concentrated gas may be followed by serious results. The remainder of the adjustment is to be completed with the free hand before the hand below the chin is removed. Officers should turn up the collars of their jackets after the skirt of the helmet has been tucked in, fixing them in front by means of a safety pin carried for the purpose or by a special button. Many cases of "gassing" have been caused by helmets not being tucked in properly under the jacket. It is desirable for all ranks to turn up their collars after completing the adjustment.

(ii) It must be seen that every man is breathing out through the valve.

(iii) Men must be warned that during a gas attack the smell of the chemical on the helmet becomes stronger and causes slight irritation of the eyes, nose and throat and that this smell does not indicate that the gas is coming through the helmet.

(iv) Men must be taught that misty eyepieces can be cleared by rubbing them against the forehead.

**Gas Alert Position:**

167. If, for any reason a man has only a P.H. helmet for use as anti-gas protection, he should wear it as follows during the alert period:

(1) Put the helmet on in the usual way. Pin the front edge of the helmet and the top edge of the opened wallet to the shirt with two safety pins in such a manner that the helmet may be readily pulled on and off the head without removing the pins, the wallet hanging loose below it.

(2) Leaving the safety pins in position, remove the helmet and fold the sides over the eyepieces to the usual width, keeping the valve horizontal and flat. Now, roll up the helmet and tuck it inside the jacket. Cover with the wallet by pulling up the latter so that it lies in front of the helmet and button up the jacket with the exception of the two upper buttons.

(3) On the gas alarm sounding, open the coat so that the helmet falls, pull the latter over the head and adjust in the usual manner. Quick adjustment is essential, and the "chin grip" should be obtained in two seconds. The wallet hangs suspended by the pins and is ready for use if required.

All equipment should be adjusted so as not to interfere with the quick putting on of the helmet, *e. g.*, nothing should be slung across the chest.

**General Points on Training With Anti-Gas Appliances:**

168. When training men in the use of anti-gas appliances the following points are of importance. They apply equally to box respirators and P.H. helmets:

(*a*) Practice in simple movements in box respirators or helmets. Ordinarily infantry drill should be combined with physical drill, including arm and leg exercises, leap-frog and doubling. The time of practice should not exceed 15 minutes at first, and should be gradually extended in the case of the P.H. helmet.

(*b*) Practice in bombing, rapid loading and aiming, judging distance and range practice, should be carried out while men are wearing box respirators or helmets.

(*c*) Men must swallow their saliva and not allow it to drain out over their lips or through the valve.

(*d*) Officers and N. C. Os. will receive the same training as the men and in addition will be practiced in giving orders whilst wearing their respirators or helmets.

169. **Practice and drill in the use of anti-gas appliances should be carried out continuously.** This applies especially to troops which have returned to trench warfare after having been in districts where more open fighting may have led (*a*) to a temporary lapse in this training, (*b*) to the subsequent incorporation of drafts only partially trained in anti-gas measures.

# CHAPTER V.

## INSPECTION OF PERSONAL ANTI-GAS EQUIPMENT.

### A.—Box Respirators:

170. Box respirators must normally be inspected once a week and daily during "Gas Alert." Attention will be paid to the following point:—

(*a*) Boxes, facepiece, mouthpiece, noseclip, eyepieces and elastic must be in good order. If the box is rusted through the respirator must be condemned.

(*b*) Facepiece must be firmly attached to the mouthpiece and to the elbow tube.

(*c*) The metal tube inside the mouthpiece must be about ⅛-in. back from the opening of the latter.

(*d*) The rubber tube must be intact and firmly attached to the box and elbow tube.

(*e*) The expiratory valve should be tested by removing the box from the satchel and either closing the cap at the bottom with the hand, or pinching the rubber tube so as to prevent inlet of air at the same time attempting to draw in air through the mouthpiece. It should not be possible to draw in any air. This also proves the absence of leaks in the tube or box. It must be possible to breathe out easily through the valve. If the latter has stuck because of saliva drying in it, this must be remedied by rubbing the valve between the fingers.

(*f*) See that the inlet valve is opening properly and that air can be drawn freely through the box.

(*g*) See that the whipcord is present and not knotted.

(*h*) Any small perforations in the facepiece should be temporarily repaired by applying pieces of adhesive plaster from the repair outfit to the perforation, both inside and outside the mask. The adhesive plaster should be large enough to overlap the hole all round.

Respirators so repaired must be exchanged as soon as possible.

(*i*) Replace the box in the satchel so that the facepiece comes to the face without twist on the tube. Fold facepiece carefully and replace in the satchel so that the expiratory valve is not likely to crumple.

**B.—P. H. Helmets:**

171. Helmets must be inspected once a week, or daily during "Gas Alert." Attention must be paid to the following points:—

(*a*) See that the satchel and wallet are in good order.

(*b*) Folding. See that the helmet is properly folded with the valve flat, and no strain on the flannelette round the valve seating.

The folding should be done as follows:—

Hold the helmet under the chin with the eyepieces away from the body.

Arrange the valve so that it lies flat pointing to the right (Fig. 2).

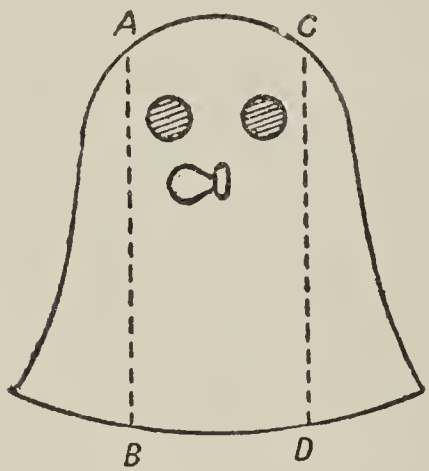


Fig. 2.

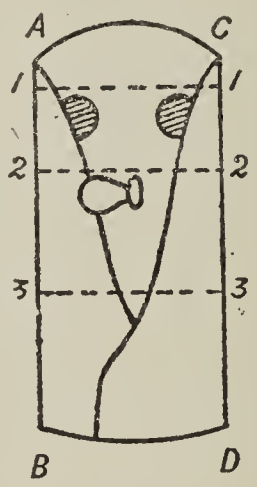


Fig. 3.

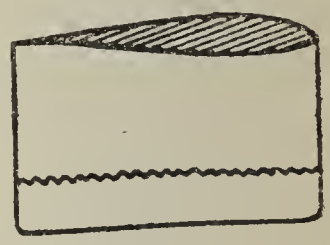

Fig. 4.

Fold the right hand edge of the helmet forward along AB, arranging the valve to lie flat on top of the fold. Then fold the left-hand edge forward along CD (Fig 3).

Fold over top along line 1.1, then along line 2.2, and finally along 3.3.

The skirt should be now folded over and the folded helmet should appear as in Fig. 4. This should now be placed in the wallet with the skirt next to the flap side of the wallet.

(*c*) Valves. The two parts of the valve screw together. The joint should be tight and should grip the flannelette. The mouthpiece should be horizontal. See that the rubber valve is fastened securely to the metal. Each

man must test the valve of his helmet by breathing through it. He should not be able to breath IN easily through the valve. The valve rubber sometimes becomes hard. This can be remedied by breathing out through the valve for about a minute at each helmet inspection.

(*d*) Eyepieces. These should be screwed up tightly from the inside and should grip the flannelette. Screw threads must not be crossed. The glasses must not be cracked or loose.

(*e*) There must not be the smallest hole through which gas might enter. Particular attention must be paid to the flannelette round the eyepieces and valve seating.

(*f*) If helmets become so sodden with water that it is impossible to breathe through them, they must then be con-

**C.—Anti-Gas Goggles:**

172. Goggles must be inspected weekly and the following points specially noted:—

(*a*) The windows should be unbroken.

(*b*) Elastic or tapes must be in good condition.

**Treatment With Anti-Dimming Composition:**

After each inspection the windows should be treated afresh with Anti-dimming Composition. This should be done as follows: Apply a little of the paste with a dry rag to the inside of the eyepiece, rubbing it hard into the glass or film. Then polish off as much as possible with a dry rag, leaving the glass quite clear. This process must be repeated after each time that goggles have been worn.

# CHAPTER VI.

## DIRECTIONS FOR THE USE OF ANTI-GAS HORSE RESPIRATOR.

### 1.—Description:

173. The respirator consists of a flannelette bag with a canvas mouthpiece which goes into the horse's mouth and saves the flannelette from being bitten through. The bag is provided with an elastic band which passes round the opening so as to draw the respirator close to the face when in use. The upper side of the mouth of the flannelette bag is furnished with a small unbleached calico patch by which the respirator is attached to the noseband of the head collar when in the "alert" position, and while in use. Inside the bag and attached to the canvas mouthpiece there is a canvas frame which is sititched on to the bag in such a way as to prevent the material drawing into the nostrils when the respirator is in use. The whole is folded and carried in a canvas case provided with a flap, secured by three press buttons, and having two straps at the back by which the case is attached to the head collar.

### 2.—Method of Use:

174. Horses can stand a higher concentration of gas than human beings without material damage, and it is not therefore necessary to protect them against cloud gas attacks when they are a considerable distance back from the trenches. Nor is it necessary to protect their eyes. The respirator is primarily intended for use on transport animals when they are sent to the vicinity of the trenches with supplies, ammunition, etc. In the case of gas shell attacks, horses should be protected wherever the shelling is heavy.

### (1)—Carrying When Not Immediately Required:

175. When not required for immediate use the respirator can be conveniently carried on the supporting strap of the breast harness as shown in Fig. 5, or if a zinc wither pad is worn, still more conveniently inside this pad. However carried, the case is steadied by being strapped on either side to the metal ring on the supporting strap, and its flap should be passed under this

strap, between it and the numnah wither pad, and buttoned as in the "alert" position.

(2) **Alert Position:**

176. When horses are being sent up to the trenches, the transport or other officer responsible should have the respirators adjusted in the "alert" position before moving off, as follows:

(*a*) The flap of the respirator case is unbuttoned and slipped under the nose-band of the head collar from below upwards.

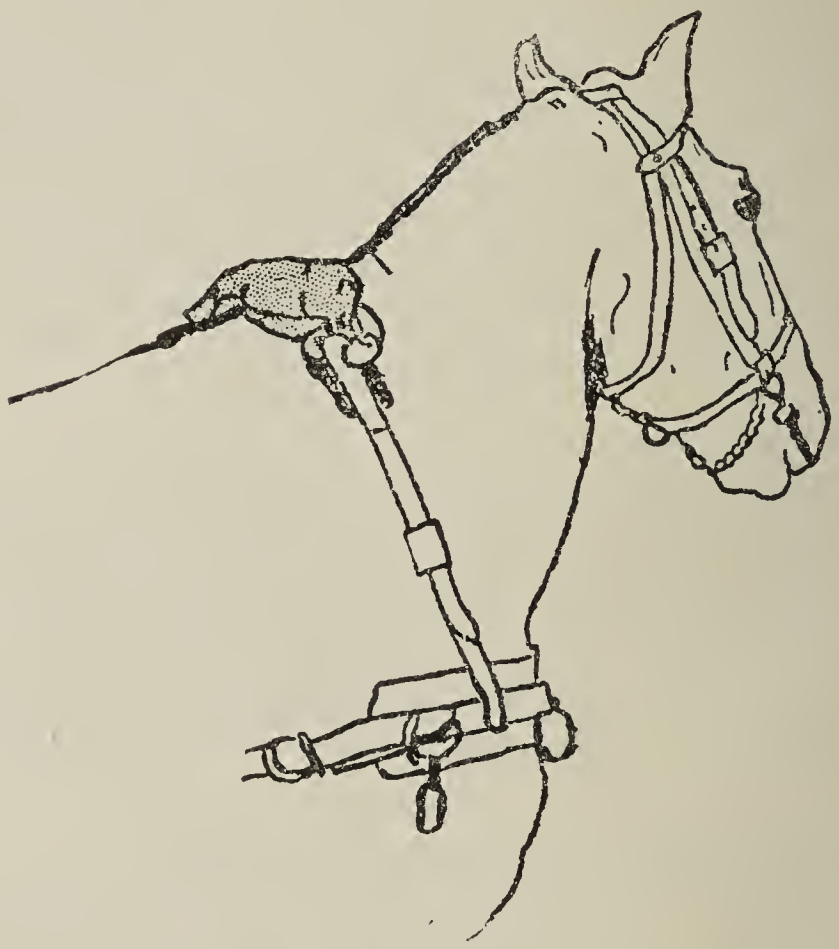

Fig. 5.

(*b*) The two straps at the back are also passed under the nose-band and secured to the check pieces of the head collar, above the metal D on each side.

(*c*) The small unbleached calico patch on the upper side of the mouth of the respirator is buttoned on to the noseband of the head collar so that the respirator is ready to be slipped on immediately in the event of a gas attack.

(*d*) The cover of the case is then closed over the noseband, and the respirator is thus protected from rain, etc., and

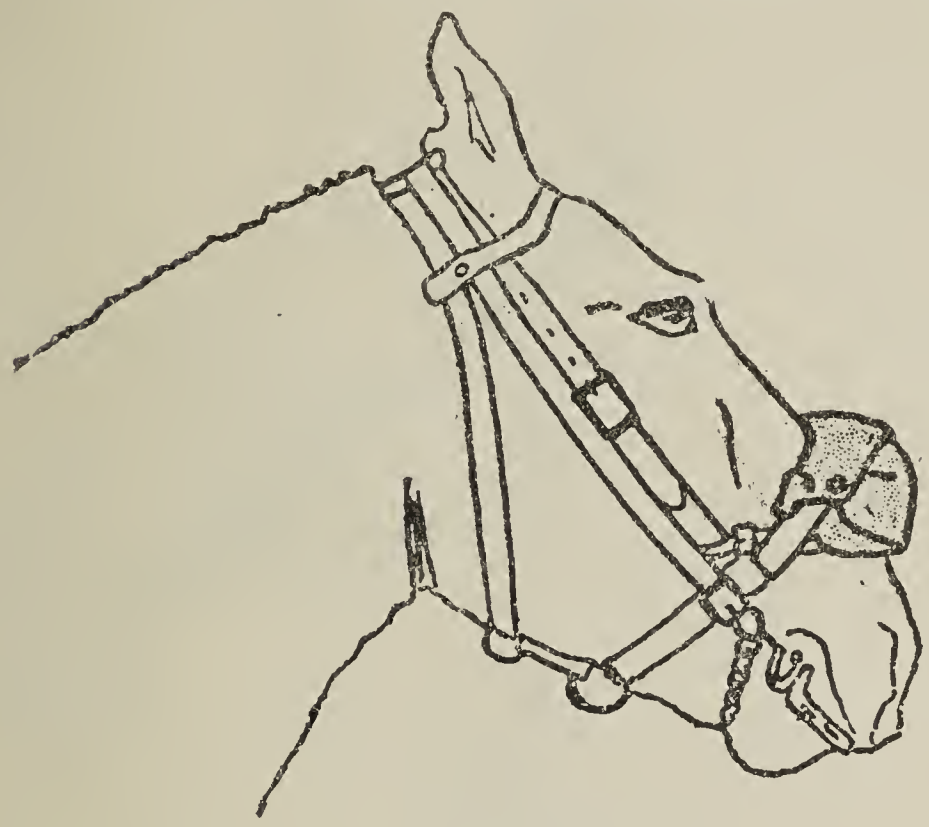

Fig. 6.

held in position on the noseband. Fig. 6 shows a respirator in its case carried in the "alert" position.

(3) Wearing in Gas:

177. The respirator being carried in the "alert" position is adjusted for use as follows:—

(*a*) The flap of the case is unbuttoned and the respirator removed, leaving the case attached to the cheek pieces of the head collar and lying flat on the face.

(*b*) The mouth of the bag is drawn down over the upper lip and upper teeth with one hand on each side of the mouthpiece, slipped into the mouth, and drawn well up to the angle of the lips.

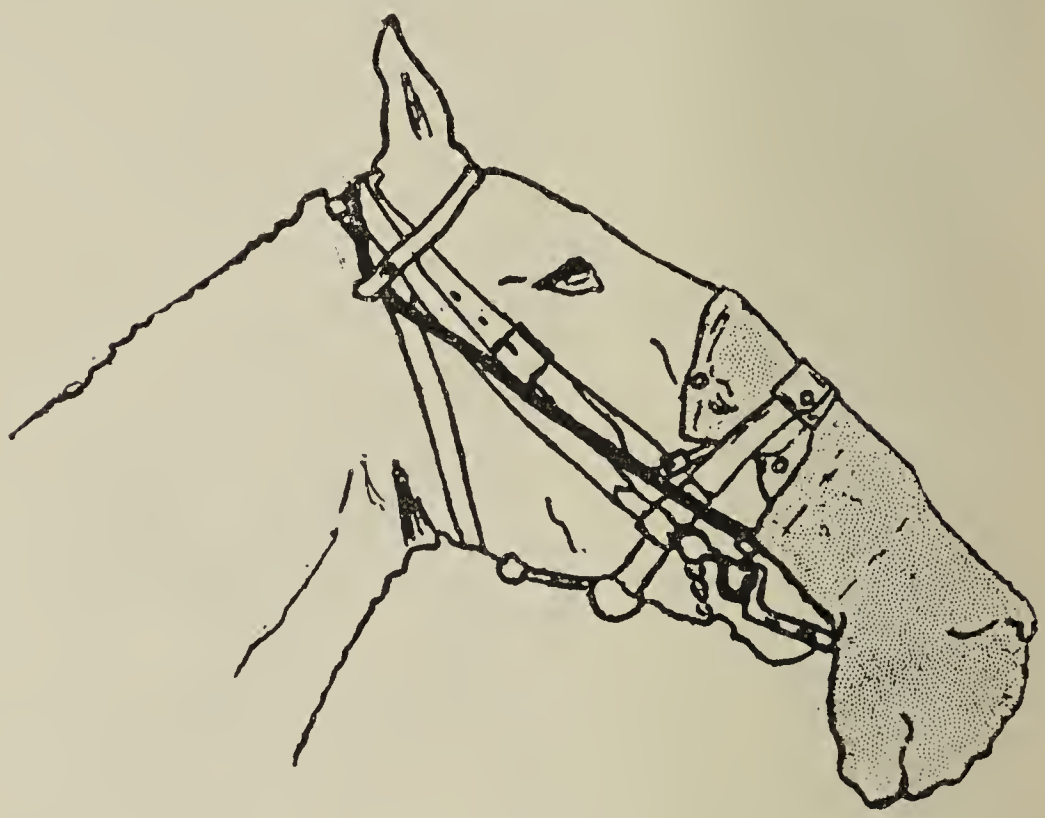

Fig. 7.

(*c*) The elastic band is seized on either side close to the mouthpiece and pulled outward so as to draw the mouth of the bag tight around the upper jaw, above the nostrils, and is then slipped over the poll.

The respirator is then in position and the animal may be worked in it without difficulty or undue distress. The bit and reins are not interfered with in any way. This is shown in Fig. 7.

GAS MASK FOR WAR DOG

(4) Replacement in Case:

178. In folding the respirator and replacing it in the case ready for use the following points should be observed:—

(*a*) The canvas mouthpiece should be wiped as clean as possible.

(*b*) The flannelette bag should be held with the canvas mouthpiece underneath and the elastic band placed over the top of the bag in such a way that when the canvas patch is buttoned on to the noseband the elastic band has simply to be passed straight up over the face and over the poll. The bottom end of the respirator should then be tucked in and rolled up over the elastic band to make a neat roll for insertion in the canvas case.

179. The dogs employed by the French in aiding the wounded and carrying messages through the trenches are wonderfully trained and show extraordinary intelligence.

# CHAPTER VII.

## TYPICAL STANDING ORDERS FOR ACTION DURING GAS ALERT AND HOSTILE GAS ATTACKS.

NOTE.—*These are Specimen Orders for guidance of Commanders in Drawing up their own Orders.*

### 1.—ORDERING OF GAS ALERT.

180. Gas alert will be ordered when the wind is in the dangerous quarter, no matter what the strength of the wind.

The order "Gas Alert" will be sent out to all units by Corps H. Q. (or, if authority has been so delegated, by Divisional H. Q.), but Brigade H. Q. or Battalion Commanders are empowered to order a "Gas Alert" as a result of wind observations made by Company Gas N. C. Os. forwarded by Company Commanders. Such action will be reported immediately to the next higher formation.

"Gas Alert" will not be taken off without the authority of the Corps Commander, or the Divisional Commander to whom authority has been delegated.

### 2.—BEHAVIOR DURING GAS ALERT.

**Inspection of Box Respirators and Helmets:**

181. (i) All box respirators and helmets will be carefully inspected and the inspection repeated daily.

**Alert Position for Box Respirators:**

(ii) All ranks within one mile of the front line will carry their box respirators in the alert position. Nothing slung across the chest must interfere with the immediate use of the respirator.

**Special Orders for Men Using P. H Helmets:**

(iii) The helmet will be carried in the alert position, i. e., pinned through the wallet on to the shirt and rolled in such a manner as to protect the valve and leave the helmet suspended ready to put on the moment the jacket is opened.

(iv) The two upper buttons of both jacket and greatcoat will be left undone. Men are forbidden to wear mackintosh sheets round their shoulders or mufflers round their necks.

(v) In no circumstances will anything (rifle, field glasses, etc.) be slung across the chest in such a manner as to interfere with the rapid adjustment of the helmet.

(vi) Jackets will not be taken off within one mile of the front line.

(vii) Officers and N. C. Os. in charge of any unit or party must see that the orders (i) to (vi) are strictly carried out both for troops in front line trenches and for detached bodies of troops (working and carrying parties, etc.).

**Sentries, Etc.:**

(viii) All working parties will have a sentry posted to give instant warning of a gas attack.

(ix) A sentry will be posted at each Strombos Horn or other alarm device and instructed in its use.

(x) A sentry will be posted to every large dug-out and to each group of small dug-outs.

(xi) A sentry will be posted to each Headquarters, Signal office and independent body of men.

(xii) Arrangements will be made by the officer in charge of the trench for warning the Artillery Observation Post if there is one in the trench.

(xiii) Commanders of units in billets within eight miles of the front line trenches will organize a system of giving the alarm and rousing all men in cellars or houses.

(xiv) At night sentries must have at least two men within reach of them so that the alarm can be spread rapidly.

**Sleeping:**

(xv) When a gas attack is probable, men in front line trenches will sleep on the fire-step instead of in dug-outs.

(xvi) Men sleeping in rearward lines or in works where they are allowed to take off their equipment, will sleep with their box respirators on the person.

**Company Gas N. C. Os.:**

(xvii) Company Gas N. C. Os. will report to Company H. Q. in readiness to assist the Company Commander should a gas attack occur.

**Ammonia Capsules:**

(xviii) Medical officers i/c units must see that a proper proportion of the ammonia capsules are with stretcher bearers in the front line in readiness for their immediate use after a gas attack.

## 3.—GAS ALARM.

182. (i) In the event of an enemy gas attack the alarm will at once be given by all means available—by telephone Strombos Horn, gongs and, if necessary, by orderly. Sentries will warn all ranks in trenches, dug-outs, observation posts or mine shafts.

(ii) All ranks will at once put on their box respirators or helmets.

(iii) Troops in the front line trenches and elsewhere where the tactical situation requires it, will stand to arms. All ranks in the front lines are forbidden to remain in, or go into dug-outs or move to a flank or to the rear.

(iv) If troops in support or reserve lines of trenches remain in, or go into, unprotected dug-outs, they must continue to wear their anti-gas appliances.

**Unnecessary Movement to Cease:**

(v) There must be as little movement and talking as possible.

(vi) On the alarm being given, all bodies of troops or transport on the move will halt and all working parties cease work until the gas cloud has passed.

(vii) If a relief is going on, units should stand steady as far as possible until the gas cloud has passed.

(viii) Supports and parties bringing up ammunition and grenades will only be moved up if the tactical situation demands.

**Protected Shelters:**

(ix) The blanket doorways of protected dug-outs, cellars, etc., will be let down and carefully fixed in position.

## 4.— ACTION DURING AN ENEMY GAS ATTACK.

183. (i) Should the gas cloud be unaccompanied by an infantry attack, the signal for gas will be sent and the S. O. S signal will not be made unless an infantry attack develops.

**Tactical Measures:**

The troops in the front trenches will open a slow rate of rifle fire against the enemy trenches: occasional short bursts should be fired from machine guns to ascertain that these are in working order. All available howitzers should be turned on the enemy's trenches from which the gas is being emitted, or in which the enemy infantry may be concentrating for the assault.

(ii) Should an infantry attack develop, the normal procedure of S. O. S. will be carried out.

(iii) Troops in the front line must be prepared to bring a cross fire to bear on the enemy attempting to advance against a gassed portion of the line.

**Movement:**

(iv) **All movement must be reduced to a minimum. There should be as little moving about and talking as possible** in the trenches. Men must be made to realize that, with the gas now used by the enemy, the observance of this rule may be essential for their safety.

## 5.—ACTION AFTER AN ENEMY GAS ATTACK.

**Removal of Respirators, etc.:**

184. (i) Men in charge of anti-gas fans will use them as soon as the gas cloud has passed, so as to admit of respirators being removed.

(ii) Box respirators and helmets will not be removed after a gas attack until permission has been given by the Company Commander who will, when possible, ascertain from officers and N.C.Os. who have been trained at a Gas School that it is safe to do so.

**Preparation for a Subsequent Attack:**

(iii) So as to be ready for a subsequent gas cloud, all ranks will replace their box respirators or helmets in the "Alert" position.

A sharp lookout must be maintained for a repetition of the gas attack as long as the wind continues in the dangerous quarter.

**Clearing of Shelters:**

(iv) Dug-outs, cellars, etc., must not be entered before they have been thoroughly ventilated, except by men wearing box respirators

or helmets. Thorough ventilation, by means of fires or anti-gas fans, is the only sure way of clearing a shelter.

**Movement:**

(v) No man suffering from the effects of gas is to be allowed to walk to the dressing station.

(vi) The clearing of trenches and dug-outs must not be carried out by men who have been affected by the gas.

(vii) After a gas attack, troops in the front trenches are to be relieved of all fatigue and carrying work for 24 hours by sending up working parties from companies in rear.

(viii) Horses which have been exposed to the gas should not be worked for 24 hours if it can be avoided.

**Cleaning of Arms:**

(ix) Rifles and machine guns must be cleaned after a gas attack. Oil cleaning will prevent corrosion for 12 hours, but the first opportunity must be taken to clean all parts in boiling water containing a little soda.

## 6.—ACTION DURING A GAS SHELL BOMBARDMENT.

185. (i) Box respirators or helmets will be worn in the area shelled.

(ii) Arrangements must be made for giving a *local alarm* in the event of a sudden and intense bombardment with gas shells.

(iii) All dugouts and shelters in the vicinity will be visited and any sleeping men roused.

# CHAPTER VIII.

## TYPICAL STANDING ORDERS FOR COMPANY GAS N.C.Os.

186. (i) They will assist officers at the inspection of box respirators, helmets and goggles and in making such local repairs as are possible. They will assist in training men in the use of anti-gas appliances.

(ii) Under the Company Commander they will have charge of all anti-gas trench stores as follows:

(*a*) **Strombos Horns and Other Gas Alarm Devices.**—Inspect daily and see that sentries posted to them know how they should be used.

(*b*) **Gas-proof Shelters.**—See that the blanket doorways fit and are kept in good order.

(*c*) **Anti-gas Fans.**—See that they are in their proper position and in serviceable condition.

(*d*) Stores of fuel for clearing shelters.—Insure sufficient supply for clearing all dug-outs, to be maintained under company arrangements.

(*e*) **Vermorel Sprayers.**—Maintain in working order and see that supply of solution is available.

(*f*) **Gas Sampling Apparatus.**—Have charge of the vacuum bulbs and gas-testing tubes. Keep a stock of corked bottles and small tins with well-fitting lids for collecting samples of earth and water after a gas shell attack.

(iii) On relief they will assist the Company Commander in taking over all anti-gas trench stores. The Company Gas N. C. Os. should accompany the advance party and take over anti-gas trench stores (by daylight if possible).

(iv) They will make wind observations every three hours, or more frequently if the wind is in or nearing a dangerous quarter and will report any change of wind to the Company Commander.

(v) During a gas cloud attack they will take gas samples by means of the vacuum bulbs and gas-testing tubes.

(vi) During or after the attack the N.C.O. must note down in writing as much information regarding the attack as possible.

(vii) As soon as possible after the conclusion of a gas shell bombardment, the gas N.C.O. must fill his bottles and tins (ii) (*f*) and take samples of water, mud, or earth from those parts of the line which are smelling most strongly of shell gases. He should note the position of any blind shells.

(viii) As soon as possible after a gas attack, all samples and notes will be handed in to the Company Commander for transmission to the Divisional Gas Officer.

# CHAPTER IX.

## INSTRUCTIONS FOR MAKING WIND OBSERVATIONS AND FURNISHING REPORTS.

Wind reports are to be made and handed to the Company Commander every three hours, or oftener if the wind is in or approaching a dangerous quarter. In order to make these reports the following points must be attended to:

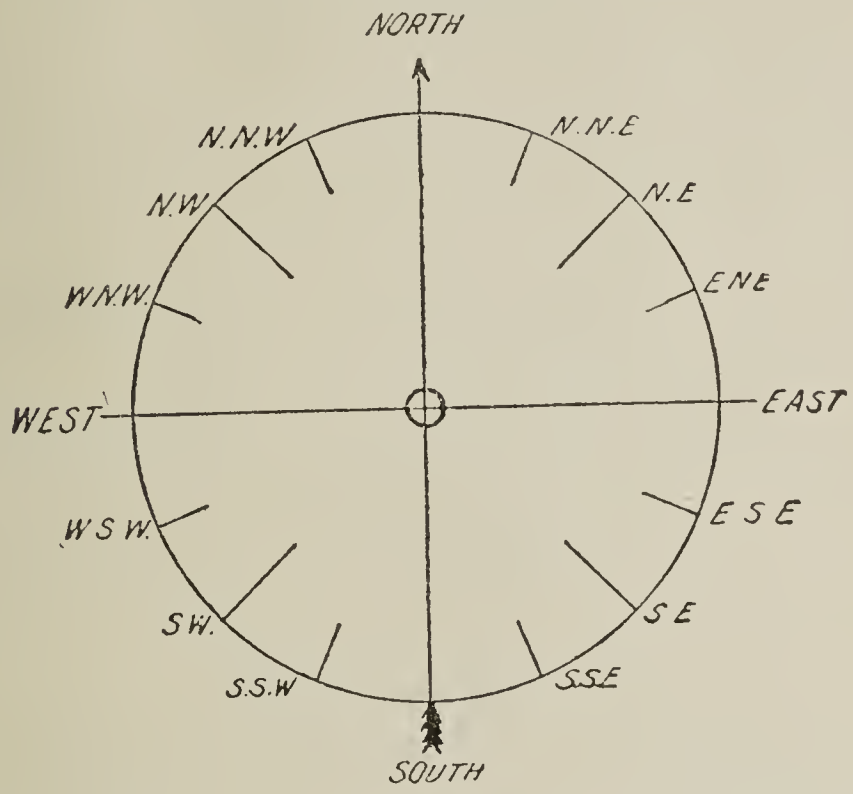


Fig. 8.

### 1.—WIND VANE.

187. A simple wind vane must be set up. *The vane must have as little friction as possible,* so that a wind of under 2 miles per hour will turn it. A little post at the top of the vane should carry a strip of linen 5 in. by $\frac{3}{4}$ in., by the movements of which the strength of the wind can be judged.

The vane must be set up sufficiently high to get a true observation (*e. g.*, 18 in. above the top of the dug-out, etc.). Correct orientation should be obtained by getting N by the N star and S by the sun at midday (Greenwich time).

## 2.— DIRECTION OF WIND.

188. Before reading the direction of the wind from the vane the observer should gauge the approximate direction by noting the course taken by smoke, etc. Direction of wind must be stated in points of the compass. The points of the compass to be used are shown in Fig. 8.

## 3.— STRENGTH OF WIND.

This may be judged from Beaufort's scale.

| Beaufort's No. | Speed in m.p.h. | Observations of Natural objects. | Behavior of flag at Top of Vane. |
|---|---|---|---|
| 0 | 0 | Smoke straight up. | No movement. |
| 1 | 2 | Smoke slants. | No movement. |
| 2 | 5 | Felt on face. | Slight. |
| 3 | 10 | Paper, etc., moved. | ¾ up. |
| 4 | 15 | Bushes sway. | Up and falling often. |
| 5 | 20 | Tree tops sway. Wavelets on water. | Up. Falling less often. |
| 6 | 30 | Trees sway and whistle. | Up and flapping. |

## 4.— TYPE OF REPORT.

189. The points NORTH, SOUTH, EAST and WEST must be written in full. Other points are denoted by the usual letters.

The following example shows the type of report which should be made.

*Wind Report.*

Trench No. 131. Date 16-10-16.

| Time. | Direction. | Speed. |
|---|---|---|
| 6 p.m..... | N.N.W..... | 12 m.p.h. |

## 5.—WARNING AVAILABLE.

190. The following simple calculation determines the number of seconds which it will take for a gas cloud to move from the enemy's lines to our own:

Double trench distance (in yards) and divide by speed of wind (in m.p.h.). Example $= \frac{100 \times 2}{10} = 20$ seconds.

# CHAPTER X.

## INSTRUCTIONS FOR TAKING GAS SAMPLES AND FOR REPORTING ON HOSTILE GAS ATTACKS.

### 1.— Taking Gas Samples During A Cloud Gas Attack.

### A.— Vacuum Bulbs:

191. (*a*) Open the hinged lid at the end of the box containing the bulb.

(*b*) Remove the file from the plasticine stopping and with it make a scratch on the glass tube at the narrowest point.

(*c*) Hold the tube with finger and thumb of each hand and snap it where it is scratched; air will immediately rush in and fill the bulb

(*d*) The box should be held as high as possible in the trench when the sample is taken.

(*e*) Press home the cap containing plasticine over the broken end of the tube so as to seal up the contents of the bulb.

Samples of gas should be taken both in the fire and support trenches. The first sample should be taken about *two* minutes after the commencement of the attack and other samples at intervals during the attack.

The exact time and place should be noted on the form on the back of the box immediately after the sample is taken.

I.f, when the gas waves have passed, any bulbs remain unused, samples of air in unprotected dug-outs should be taken before the latter are cleared.

Immediately after vacuum bulbs have been used they should be taken under shelter.

### B.— Gas-Testing Tubes:

In the intervals of taking gas samples with vacuum bulbs a **Gas Testing Tube** should be used. Open the box by stripping off the adhesive plaster and pulling off the lid; pull out the small glass stopper and pump air through the apparatus by squeezing the rubber ball in the hand for 10 minutes. If the number of times the ball is squeezed is counted and recorded, useful information may be obtained. After the sample has been taken, replace the small glass stopper, and *at once* replace the lid of the

box, taking care to avoid compressing the rubber ball. Note on the label the time and place at which the sample was taken.

**2.—Collection of Specimens After a Gas Shell Bombardment:**

192. As soon as possible after the conclusion of a gas shell bombardment, the Gas N.C.O. must take samples of water or earth from those parts of the line which are smelling most strongly of shell gases. He should note the spots at which the samples were taken.

During and after a gas attack the Gas N.C.O. should note down in writing as much information as possible on the following points:

(*a*) Strength and direction of wind and general weather conditions.
(*b*) Times at which the gas wave or gas shell bombardment started and finished.
(*c*) Exact position and nature of place affected by gas or gas shells.
(*d*) Color and color changes of the gas cloud.
(*e*) Sound of escaping gas.
(*f*) Smell of gas and gas shells.
(*g*) Effect of gas and gas shells on men.
(*h*) To what extent telephone dugouts, covered gun and machine gun emplacements, etc., were affected.
(*i*) The approximate number of gas shells used and their calibre.
(*j*) The position of blind shells and fragments of shells, etc.

**3.—Forwarding of Samples, Specimens and Reports:**

193. After an attack, cloud gas samples, gas testing tubes, gas shell bases and fragments, shell gas samples and notes on the attack will be handed to the Company Commander as soon as possible for transmission to the Divisional Gas Officer.

**Gas Precautions:**

194. Do you and your men thoroughly understand the order regarding "gas precautions"? Have you got your proper number of gas masks, box respirators, etc.? Have you got Vermorel sprayers and solution properly stored for them? Are the gas blankets in position at entrances of your dug-outs? Do you carry out "gas drill," and do you thoroughly comply with the orders for "Gas alert" period?

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THE PHOTO SHOWS A LIQUID FIRE OR FLAME-THROWING ATTACK IN PROGRESS.

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"RAIN OF FIRE" WAR'S LATEST DEADLY WEAPON.

French soldiers in a trench of the very front lines shooting the flames into the German trenches. The German trench is only several hundred yards away and the flames cause great injuries and damage. This remarkable photo shows the men actually using the instruments for throwing the flames. The "Flame-thrower" was first introduced by the Germans. The Allies perfected the weapon and now the Germans have to face their own kind of warfare, much to their discomfiture. The "flame-thrower" looks somewhat like a fire extinguisher and is carried over the back, while the flames shoot from an extension that is held in the hands.

# CHAPTER XI.

## GAS IN THE OFFENSE.

### PART 1.— LIQUID FIRE.

195. The latest and most diabolical warfare to be introduced was originated by the Germans. It is called the "Flammenwerfer" or "Flame Thrower" and instead of spreading gas it actually throws flames.

It is now a favorite German institution, but occasionally it gets into trouble by being exploded by shell fire in the hands of the man using it.

The "Flammenwerfer" looks somewhat like a fire extinguisher and is hung on the back of the soldier while an extension that is held in the hands throws the flames. The cylinder contains oil and compressed gas. As the oil is forced out of the cylinder by the compressed gas it catches fire and spreads out in a sheet of flame and smoke. A single flammenwerfer can cover a frontage of about 6 yards when stationary and the flame burns for about one minute. The extreme range at present is only about 50-60 yards, but this is being increased to 200 — 300 yards. The kind of oil used depends upon the atmosphere.

The discharge is accompanied by a loud roar, yellowish red flames and a dense black smoke making it very difficult for green troops to realize that it is effective for only the short distance above mentioned.

While the heat of the flames is intense the burning takes place entirely in the air and the stream cannot be turned downward as the heat causes an upward current.

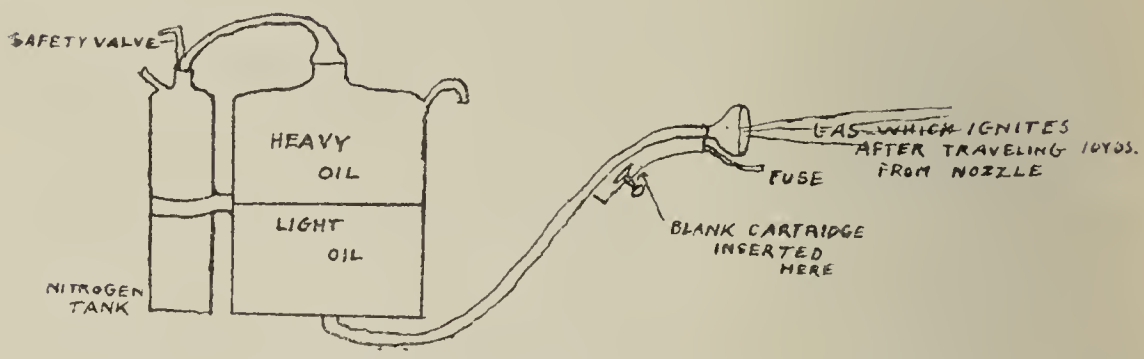
Protection is easily obtained by any non-inflammable cover above and a soldier is safe if kneeling on a fire step or just within the entrance of a dug-out.

196. **Rain of fire.**— War's latest deadly weapon — French soldiers in a trench of the very front lines shooting the flames into the German trenches. The Hun trench is only several hundred yards away and the flames cause great injuries and damage. This photograph shows the men actually using the instruments for throwing the flames. The "Flame thrower" was first introduced

by the Huns. The Allies perfected the weapon and now the Germans have to face their own kind of warfare much to their discomfiture.

## FLAMMENWERFER.

(Flaming Liquid.)




197. Two principal kinds, small — carried by one man. Large — placed in larger places.

Iron container, 3 feet long by 1½ feet wide, two hooks for the body.

Mixture of heavy and light oil plus gasoline.

Its range is from 50 to 60 yards. New ones will carry from 200 to 300 yards.

It is very dangerous to handle. In the German army only special men handle these weapons.

Kinds of oils they use are according to the atmosphere.

This attack is fatal to whatever it touches.

## PART 2.— SMOKE BOMBS.

198. The discharge of gas and smoke or smoke alone is regarded by the enemy as a prelude to the assault, and usually draws his barrage on the trenches from which the discharges are issuing.

This may be taken advantage of to determine the general line of the enemy barrage so that arrangements can be made to avoid casualties later when the real assault takes place.

If smoke is used just before the assault to conceal the advance, it may cause the assaulting troops to lose the way and bring down the enemy barrage prematurely but it may be use-

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PHOTOGRAPH OF A "FLAME-THROWING" ATTACK.

The latest and most diabolical warfare to be introduced was originated by the Germans. It is called the "Flammenwerfer" or "Flame-Thrower" and instead of spreading gas it actually throws flames. This photograph shows the French troops making a rushing attack with the flame-throwers. The air is filled with smoke and flames which are deadly. The weapon was first brought out by the Germans. The Allies perfected the machine and turned it on the enemy with great success. The Germans did not like their own medicine.

fully employed over those portions of the front from which no assault is taking place.

Smoke bombs may be used during the advance (a) to blind any machine guns likely to cause trouble, especially on the flanks and (b) to conceal the advance of the reserves.

As regards (a) this is especially effective on flanks of the attack.

The smoke barrage must start at zero and should be as rapid as possible to insure the smoke screen being forward before the enemy has time to discover our advance.

As regards (b) a smoke screen can be employed where reserves detailed for the assault of a later objective have to cross a long stretch of open ground exposed to view by the enemy between our jumping off trenches and the line already gained by our troops.

To effect this the mortars should be sent forward as soon as possible after the first objective has been captured in order to give them time to establish themselves in a forward position to get up the necessary ammunition.

Where possible the detachments of the special Brigade which will be working with the Division in the assault should be present during the training and should actually practice the barrages required in order that the troops especially in the advance of the reserves may be given practice in advancing through the smoke without losing direction.

## PART 3.—THE TACTICAL EMPLOYMENT OF GAS IN OFFENSE.

199. Gas having been generally adopted in all armies, a knowledge of the technique of its employment in offense must be considered.

As has been noted, gas may be employed in the form of gas clouds or waves, gas shells, gas trench mortar bombs, hand bombs and grenades. The proper use of gas in the form of a cloud attack is of so technical a character that its employment should be delegated to specially trained gas companies attached to each division. In the English Army an entire brigade of Royal Army engineers has been organized for the gas offensive. This brigade is under the command of a general officer attached to army headquarters. When a gas-cloud attack has been decided

upon the gas officer should make a survey of the sector involved and designate the location of the batteries of gas containers. These batteries, which may vary from 3 to 12 containers, are placed in specially prepared emplacements under the front line parapets and thoroughly protected from shell fire. Inasmuch as the trenches never follow a straight line the batteries must be so located that when the gas is released it will not "enfilade" the trench containing them. Advantage must be taken of salients so facing the enemy that the wind will carry the gas in the proper direction. The best distribution of the gas can be accomplished with batteries placed at intervals of from 30 to 40 yards.

The weather conditions being of such great moment in the proper accomplishment of a gas-cloud attack, they should always be studied thoroughly. To this end meterological stations should be established along the front and daily observations recorded, tabulated, and charted. The ideal weather is a gentle wind blowing in the right direction at a rate of 4 to 6 miles per hour; fairly high humidity, 40 to 60 per cent, and an overcast sky. The upward current of warm air on a sunny day rapidly dissipates the gas and on such a day the best time for attack is in the early morning or late afternoon.

The order for a gas attack should be given in detail. It should state that at ——— hour on the first day when weather conditions are suitable a gas attack will be made on ——— sector of the front and the number of gas waves (rarely more than three) and the time for releasing each wave (so many minutes after ——— hour) will be started. Each day of the week should be given a code designation for some days in advance. By this means when the proper weather condition arrives, notification to attack can be given by signaling the code name. The artillery should have orders to open fire on the enemy trenches immediately after the gas wave has arrived and a heavy barrage fire also instituted to prevent the bringing up of reinforcements. For this barrage gas shells are especially useful.

## PART 4.—METHOD OF MAKING A GAS ATTACK.

200. The gas-wave attack is practically always followed by an infantry attack, and therefore the most perfect coordination is necessary between the "gas detail," the artillery, and the infantry,

When an attack is to be made, men are placed in charge of each battery to release the gas when the order is given. Each battery is connected by telephone with an officer of the gas service responsible for a given sector of the front, and he in turn with the line officer commanding that sector. The latter is connected with local and distant meterological stations and with artillery headquarters.

The time for delivering the infantry attack will vary somewhat with the atmospheric condition under which the gas was liberated. Sufficient time should elapse for at least part of the gas has been disseminated, for with an efficient barrage fire there is little chance of reinforcement being brought forward.

Gas-shell attacks are also dependent to some extent on the condition of the weather. Inasmuch, however, as by means of projectiles the gas can be liberated directly in the enemy's lines, weather conditions are not nearly so important as they are in the gas-cloud attack.

The employment of gas shells may be in conjunction with a gas-cloud attack, or an infantry attack without a preliminary gas-cloud attack. As mentioned above, their greatest usefulness is in establishing a heavy barrage to prevent the bringing up of reinforcements. They may also be used for a preliminary bombardment of the trenches, the noxious gases they liberate materially weakening the defense in many instances. Gas shells are also of distinct value in directing artillery fire.

## GAS AND OIL PROJECTORS.

201. Considerable use is made of projectors both for gas and oil with, it is thought, satisfactory results. The tactics pursued were to shepherd parties of the enemy into woods and leave certain routes free from heavy shelling and then to concentrate with projectors on such places.

# CHAPTER XII.

## PATHOLOGY OF GAS POISONING AND ITS TREATMENT.

### INTRODUCTION.

203. The employment of poisonous gases as a means of offensive warfare has made it imperative that medical officers should have some knowledge of the action of the various gases that are likely to be met with and of rational lines of treatment which may be adopted in cases of gas poisoning.

Poisonous gases have been used in warfare with the intention of putting men out of action, hampering artillery, preventing supports from advancing, and inspiring general terror, so that an advance may be made with a minimum of opposition and some military advantage secured. Apart from any question of an advance, poisonous gases have been used merely as a means of causing a certain number of casualties on the opposing side and of inspiring terror.

Besides this deliberate use of gas for offensive purposes, poisonous gases are liable to be encountered under other circumstances—e. g., during mining operations, or as the result of the imperfect detonation or burning of explosives.

### PART I.—THE MODE OF ACTION OF POISONING GASES.

204. Poisonous gases that are liable to be met with can be grouped roughly, according to the main physiological action that they produce on the animal body. It must, however, be clearly understood that it is impossible to draw absolute distinctions, since many of the gases partake of the characters of at least two of the groups.

### I. GASES WHICH ACT AS LUNG IRRITANTS.

205. The main characteristic of gases of this group is that they cause the onset of a profuse pulmonary edema. The accumulation of fluid in the lungs interferes with the respiratory exchange, causing intense cyanosis and death by asphyxia. In addition to this these gases are irritating to the respiratory passages, some of them intensely so, causing great pain and discomfort in the chest. They may also cause marked irritation of the eyes and lachrymation. In some cases circulatory failure is a very marked feature, and the cyanosis may then give place to

the leaden pallor of collapse. With some gases of this class mild poisoning may lead to a condition somewhat akin to atshma.

**Type 1—Chlorine**—A concentration of 1 in 100,000 can be respired for a considerable time, though this may give rise to subsequent bronchitis.

A concentration of 1 in 10,000 is barely respirable by man and experimentally is not borne for more than two or three breaths. It produces irritation of the eyes, spasm of the glottis, a feeling of choking, and severe cough. If the inhalation is continued, the struggle for breath becomes more acute and the man will be rapidly incapacitated. In such a concentration edema of the lungs commences very soon and develops steadily.

**Type 2—Nitrous fumes, i. e., nitric oxide and nitrogen peroxide**—Sensory irritation of the eyes and upper respiratory passages is slight as a rule, and passes off in a short time after leaving the dangerous atmosphere. For some time after this the man may feel perfectly well and go about his ordinary business, but after the lapse of a few hours acute symptoms of pulmonary edema suddenly come on and progress with alarming rapidity.

In contradistinction to chlorine poisoning, there is, therefore, a very definite delay before the onset of pulmonary edema, and the slightness of the symptoms shown by the man while he is in the dangerous atmosphere would not naturally lead one to anticipate the disastrous effects which may develop later.

**Type 3—Phosgene.**—In certain characteristics this gas holds an intermediate position between chlorine and nitrous fumes. Though it is a more intense eye irritant than chlorine, it is not so immediately irritant to the upper respiratory passages and there is some delay before the onset of pulmonary edema. Circulatory failure is apt to be a prominent feature and cases exhibiting a leaden pallor and collapse are the rule rather than the exception. Phosgene incapacitates a man more slowly than chlorine but is a more serious poison.

## II. Gases Which Act as Eye Irritants or Lachrymators:

206. The main characteristics of this group of gases are that in exceedingly small concentrations they exert an intense irritant effect on the eyes and cause so profuse a flow of tears and often so much pain that vision may be impossible. In stronger concentration they may also act as acute lung irritants.

**Type—Benzyl bromide.**—A very minute concentration causes marked lachrymation. A high concentration, when the eyes are protected, rapidly causes respiratory discomfort, irritation of the throat, and nausea.

### III. Gases Which Act as Direct Poisons of the Nervous System:

207. The characteristics of this group of gases are that in sufficient concentration they act on the central nervous system with great rapidity, causing a cessation and finally a total abolition of its functions. Some of these gases cause delayed pulmonary edema in cases which have not succumbed rapidly from the effects on the central nervous system.

**Type—Hydrocyanic acid.**—Minute concentrations are practically innocuous. High concentrations cause immediate unconsciousness and death in a few seconds.

Animals if taken out of the poisonous atmosphere as soon as they have fallen down paralyzed, may recover perfectly in a short time.

### IV. Gases Which Act by Interfering With the Respiratory Properties of the Blood:

208. Under this heading may be grouped cases which cause destruction of red cells, alter the hemoglobin, or combine with the hemoglobin to the exclusion of oxygen, so that severe symptoms arise because the oxygen-carrying power of the blood is interfered with. Certain cases may, for instance, lead to destruction of red cells, accompanied by hemoglobinuria or jaundice. Again, nitrous fumes in strong concentration may cause the alteration of hemoglobin into methemoglobin in addition to producing the intense irritation of the lungs mentioned above.

**Carbon monoxide.**—This gas owes its poisonous action to the fact that it combines with hemoglobin to form a dissociable compound and thereby takes the place of oxygen. Carbon monoxide has about 300 times the affinity for hemoglobin that oxygen has. If therefore a small proportion of carbon monoxide is present in the air breathed, the hemoglobin in the body will divide itself between the two gases, the final partition being determined by the relative concentration of the two gases. The oxygen-carrying power of the blood is progressively diminished as the hemoglobin

becomes more and more saturated with carbon monoxide, and symptoms arise owing to the interference with the oxygen supply to the tissues from this cause.

### Circumstances Under Which Gas Poisoning May Be Met With In Warfare:

209. Some poisonous gases of the foregoing groups are well adapted for use as offensive agents in warfare, while others are unsuitable owing to various causes, such as difficulty of manufacture or of storage, chemical instability, limited toxicity save in high concentrations or after prolonged exposure, or insufficient density. Though the acute lung irritants as a whole must be classed among the more powerful methods of destruction, nitrous fumes do not lend themselves to deliberate offensive use. They may be met with during warfare accidentally under certain circumstances. Carbon monoxide, too, is not adapted to offensive use, though it may prove a very serious factor indeed when met with during mining operations.

## PART 2.—THE USE OF GAS FOR OFFENSIVE PURPOSES.

210. **(a) Cloud gas**—The rate at which the cloud gas is carried over the ground intervening between the trenches of the two opposing forcec depends entirely on the velocity of the wind. With winds at the rates of 3, 9, and 15 miles per hour, the gas cloud would move forward at the rate of 90,270, and 450 yards per minute, respectively; and with a wind of 91 miles per hour, the distance of 100 yards would be covered in about 20 seconds. These figures indicate how short may be the time available for warning men in the front trenches of the commencement of a cloud gas attack and emphasize the extreme importance of training troops thoroughly in the use of protective devices.

**(b) Gas shells and gas bombs.**—In this case the poisonous substance is contained in liquid form in the shell or bomb and is converted into a cloud of vapor on the explosion As a rule these shells are employed to produce a toxic effect at a distance over a limited area and are most frequently used against batteries, or in the form of a "tir de barrage" to interfere with the movements of supports during an engagement.

The commonest gas shell used by the Germans contains the lachrymators, benzyl, and xylyl bromides, but shells containing acute lung irritants have aso been employed.

A cloud gas attack necessitates a favorable wind blowing toward the enemy's position, but gas shells can be used even if the wind is blowing toward the user, since if the gas is blown back, it will have been so diluted with air as to be harmless to him. A cloud gas attack may be preceded or accompanied by a gas shell attack, and gas shells of different forms may be fired not only on points behind the trenches but also on the front line and support trenches as well.

Medical officers must, therefore, remember that more than one method may be used at the same time during a gas attack and that different chemical substances may be simultaneously employed. They must in consequence be on the watch for differences in the symptoms presented by gassed cases so that they may report the facts to headquarters and adopt suitable treatment.

### Circumstances Under Which Poisonous Gases Other Than Those Used Deliberately For Offensive Purposes Are Liable To Be Encountered:

211. (*a*) **Mine gases.**—During mining operations the most dangerous gas met with is carbon monoxide. This arises from the imperfect detonation or combustion of the explosives used for charging the mine or for blasting. The galleries may be flooded with the gas after the explosion of either our own or a hostile mine, as the result of the explosion of a hostile camouflet designed to blow in our galleries, or as the result of the explosion or burning of a blasting charge. The gas is liable to be driven into the ground disturbed by the explosion and to come welling out later, especially if the barometer commences to fall after the explosion, or it may be met with in the form of pockets of gas when new galleries are driven through ground disturbed by a previous explosion. Carbon monoxide has even been known to be driven out of the shafts into the adjacent trenches after the explosion of a mine.

Besides carbon monoxide, nitrous fumes may arise if a charge does not explode properly, and especially if it burns instead of exploding. Nitrous fumes are quickly absorbed by moist ground, and so cases of nitrous fumes poisoning are seldom met with unless men are exposed to the fumes immediately after the explosion or the burning of the charge.

(*b*) **Fumes from high-explosive shells.**—Nitrous fumes have so far given rise to no cases of poisoning after the explosion of high-explosive shells. Cases of carbon monoxide poisoning have been known to arise under special circumstances—*e. g.*, when a shell has penetrated into a deep dug-out before bursting. Such cases are, however, unlikely to arise unless the shell explodes in a confined space, since either a high concentration or a prolonged exposure is required for the production of symptoms.

(*c*) **Fumes from the firing of guns.**—In closed machine-gun emplacements, owing to the blowback from the gun, enough CO sometimes gets into the air to give rise to symptoms. Symptoms of CO poisoning are also sometimes caused in gun pits owing to the blowback on opening the breech when certain forms of powder are used.

(*d*) **Burning of nitro explosives.**—If nitro explosives are accidentally set on fire and continue to burn without explosion, there is great danger of poisoning from nitrous fumes. Carbon monoxide poisoning may also occur.

(e) **Burning buildings.**—It must be remembered that when combustion takes place in a limited supply of air as in the interior of a burning building there is a considerable risk of carbon monoxide poisoning.

(f) **Warming of billets.**—A burning coke brazier in a small, ill-ventilated billet is very likely to give rise to cases of carbon monoxide poisoning.

**Poisoning by Gas Cloud :**

212. The gas used by the Germans in attacks made on the English trenches by poisonous clouds drifting forward on the wind was in the early summer of 1915 chiefly, if not solely, chlorine. Later it became apparent from the change of symptoms in casualties that a different form of gas was being employed and this is believed, though not proved, to be a mixture of chlorine with varying proportions of carbonyl chloride or phosgene gas. It is, therefore, necessary to describe separately the action of each type of cloud gas.

## PART 3.—CLOUD GAS OF 1915, 1916, 1917.

**Cloud Gas of Summer of 1915 :**

213. The following account of the pathological changes is based entirely upon observations made on men injured by German cloud

gas in 1915, and these observations coincide with what has been noted in laboratory experiments with chlorine. The effects may be classified under the following headings :

Irritation and inflammation of the respiratory tract.
Interference with the circulation.
General toxic effects.

**Respiratory Tract :**

214. Chlorine is very irritant. Sensory nerves are violently stimulated, causing immediate pain and uncontrollable reflex movements, such as coughing or spasmodic gasping, which interfere with respiration. Lachrymation is relatively slight. A heavy concentration of the gas seems almost irrespirable but the spasmodic check to breathing ultimately gives way, and no case of death from asphyxia immediately upon exposure to the gas has been proved to have occurred in the English lines. Breathing continues, but it is of a spasmodic character and accompanied by violent coughing which, as will be described later, has a very harmful effect on the lungs.

The irritation of the sensory nerves, however, is not the fatal factor. An inflammatory reaction, with congestion of the vessels, edema of the tissues and an abundant discharge of serous effusion through the dying epithelium occurs all the way down the respiratory tract. This begins at the back of the throat; the larynx, with its resistant epithelium, escapes injury, but the damage to the surface tissues increases progressively down the trachea, the bronchi and their finer branchings, and ultimately attains its maximum in the air sacs. The bronchioles are rapidly filled with a serous exudate which passes up into the trachea and is coughed out.

A universal obstruction in this way of the bronchioles alone would suffice to cause death by simple blockage of the airway and asphyxia. But the injury is not confined to the bronchial tree and probably the effusion in the tubes alone is not dense enough to hinder the passage of some air up and down, though even this thin fluid may constitute a very serious mechanical obstruction when it is churned up into a continuous foam by violent respiratory efforts. At first there may be so much spasmodic contraction of the muscles of the smaller bronchioles that the gas is denied access to many areas of the lungs. Sooner or later these relax, and the irritant vapors then destroy the pulmonary

epithelium, while the air sacs rapidly fill up with inflammatory exudate and become utterly useless for the purpose of respiratory exchange. The edematous effusion must ultimately compress the capillaries and cause great hindrance to the flow of blood through the lungs. The irritation spreads so widely that a blood-stained serous effusion soon accumulates in the pleural cavity, but this is never so abundant as to require aspiration.

In addition to this inflammatory edema, which chokes the circulation and prevents gaseous exchange, there is often some actual damage to the structure of the lungs. The violent coughing and inspiratory efforts which may result from inhalation of the gas may be so forcible that the partitions between the alveoli are torn and air may even burst its way out into the areolar tissue and escape along the hilum of the lung and up into the subcutaneous tissues of the neck. Such disruptive emphysema adds at once to the disability of the sufferer, since it throws out of action that part of the lung which is not yet submerged in the rising flood of edema fluid, and it may lead to permanent shortness of breath if the man survives.

There are, therefore, four factors which develop in rapid succession and prevent exchange of respiratory gases through the lungs :

(1) Narrowing of the bronchioles by spasmodic contraction of muscles in their walls.

(2) Disruptive emphysema.

(3) Obstruction of the bronchial tubes by exudate.

(4) Flooding of the pulmonary air sacs by serous effusion into them.

The result of these changes in the lungs, of which (3) and (4) are the most important, is that the intake of oxygen and the elimination of carbon dioxide are seriously interfered with, and the man passes into a state of asphyxial cyanosis in which mental failure and unconsciousness may rapidly supervene. During this state the breathing is labored, rapid, and interrupted by spasmodic bouts of coughing. The blue color of the face shows the urgent need for oxygen, and every muscular effort made by the body and by the heart increases that need. Coughing is helpful in so far as it may dislodge exudate from the bronchi, but the violent effort is prodigal of such oxygen as can be supplied and it tends to increase the disruptive emphysema. The increased respiration is caused both by the accumulation of carbon dioxide

and by the want of oxygen and not by the absorption of any poisonous substance from the gas. In itself, this increased breathing does no harm and it helps in eliminating $CO_2$ and increasing the intake of oxygen which are the chief needs of the moment.

**Interference with circulation.**—The ordinary phenomena in asphyxia of mechanical origin are that the blood pressure rises and that the heart soon loses its full driving power because its muscle cannot maintain this increased effort when it is working with a scanty supply of oxygen. Consequently the pulse rate quickens, the right heart dilates and the blood tends to be pooled up behind it in the great veins. If this failure proceeds apace, a patient who at the beginning showed congestive cyanosis of the face with a full pulse will gradually assume a gray pallor while the pulse accelerates and falls off in power. These changes are present in cloud gas poisoning and they are augmented by the edema of the lungs, which directly obstructs the pulmonary circulation and causes an earlier failure of the right side of the heart.

If the patient during this critical time tries to carry on his work and remain standing, he will use up still more rapidly the little oxygen that he is receiving, extra work will be loaded on to a heart which is already overstrained and the circulation will be likely to fail still more speedily on account of the difficulty of maintaining compensation in the upright posture.

There is no interference with the respiratory properties of the blood which can at once take up any oxygen that reaches it through the lungs.

**General toxic effects.**—Experiments indicate that chlorine is not absorbed from the lungs and that the effects produced by this gas are only a direct and local inflammation with secondary results which are either of a mechanical nature or caused by oxygen want or due to a nervous reflex from the seat of injury. Changes of a general nature do undeniably appear in the nervous, circulatory, alimentary, and renal systems of a man who has been poisoned by cloud gas, but these are probably the result of the asphyxia rather than of the direct action of the gas. Thus in the mild cases there is a sense of fatigue and of being altogether done up, and in the serious cases even unconsciousness, but these features are not in excess of what may result from oxygen want. The retching and vomiting that generally occur in

the first stages of poisoning may be due only to direct irritation of the back of the throat and of the stomach by the gas, or may be the direct sequence of violent bouts of coughing, while the diarrhea, which sometimes is an early feature, may be that of emotion.

Microscopic examination of the kidneys in death, a few days after gassing, reveals very definite inflammatory and destructive changes, and such kidneys may be swollen and enlarged as though with a parenchymatous nephritis. This change, however produced, rarely leads to any clinical feature of renal trouble. In the first few days the urine contains neither sugar nor albumen nor many casts, and it is very unusual for albuminuria to develop later.

The circulation may fail with unexpected rapidity and the patient soon present the aspect of a leaden gray cyanosis. But in general terms the clinical picture with chlorine may be summed up as that of a man suffering from intense irritation of the respiratory tract and dying by asphyxia from the fluid that has drowned his lungs. It does not suggest a deeper toxic action.

**Post-mortem findings.**— In a case of death at 24 hours after gassing, the trachea and bronchi are purple red and congested, while a thin serous exudate wells up into them from the lungs. The latter organs are heavy and edematous, while aerated islets of emphysematous overdistention alternate with depressed purple patches of collapse. On section, serous fluid drips abundantly from the lung tissue. Air that has escaped from ruptured vesicles is seen in chains of bubbles on the surface of the lungs, along the interlobar fissure and even penetrating the tissues of the mediastinum. In some of the earliest cases the most intense disruptive emphysema was observed, destroying the air sacs and interfering with the circulation in their walls.

Petechial hemorrhages appear on the surface of the lungs, on the heart, and also on the inner surface of the stomach. All the veins are greatly distended and the abdominal viscera are engorged with dark blood that clots very early after death. The heart itself may fail to show right-sided dilatation, for this does not of necessity appear post mortem in cases of asphyxial death.

If the man succumbs at a later date, inflammatory complications appear on the lungs. There is superficial pleurisy, scattered broncho-pneumonia, and a purulent secretion in the bronchi. The serous exudate will then be found to have disappeared and no fluid drips from the cut surface of the lungs.

## CLOUD GAS OF 1916 and 1917.

215. The symptoms tend to differ from those produced by chlorine in three main details.

(1) Subjective respiratory irritation is much less in evidence. The men do not suffer with such violent coughing when first exposed to the gas. There is consequently less disruptive emphysema of the lungs, and subcutaneous emphysema of the neck is rare, while post-mortem examination in early cases often fails to find anything more than a little escape of air along the inter lobar fissure.

(2) The poisonous effects may appear speedily with cyanotic asphyxia, but sometimes they are more insidious in their onset. A man may feel able to carry on his work for an hour or two with only trivial symptoms; then he rapidly becomes worse and passes into a state of grayish white collapse, with progressive edema of the lungs that may soon be fatal. It has even been reported from the trenches that men who have passed through a gas attack and seemed to have suffered but slightly have died abruptly some hours later upon attempting some bodily effort.

(3) Features suggestive of general collapse are more in evidence. There is a much greater tendency to circulatory failure. Many of the cases that die on the first day show a leaden gray tint of the face rather than a purple red cyanosis; the pulse is rapid and of poor tension. Mental confusion or mild delirium with restlessness and unconsciousness become more prominent in the severe cases.

No case has been reported in the armies of death immediately upon exposure to the gas, although men have gone through an attack of gas in high concentration without wearing a mask at all and succumbed in consequence an hour or more later.

The action of phosgene ($COCl_2$) differs from that of chlorine in certain respects. Upon meeting moist surfaces it is broken up and hydrochloric acid is liberated. It excites less spasm than does chlorine in the upper respiratory tract, and so can penetrate to the innermost recesses of the lungs, where it causes an irritant edema which may be a little delayed in its development, like that caused by the acids formed from nitrous fumes, although the delay in the latter case is more prolonged. Experiments do not show that the products of phosgene are absorbed from the lung and act as general poisons apart from their local action.

**Post-Mortem Findings:**

216. **Two hours after exposure to gas.**—In a case of death by asphyxial cyanosis where inflammatory effusion had developed with great rapidity the lungs were smaller than normal, heavy, uniformly airless and purple, so that each resembled a big spleen. There was no disruptive emphysema. Thin serous fluid ran abundantly from the surface when cut across. Each pleural cavity contained about 15 ounces of serous effusion.

**Second and third day.**—There is no striking difference between the cases which had shown pallid collapse and those which succumbed in extreme cyanosis. The condition of the heart is found to be variable, but there is always evidence in the viscera of vascular engorgement from failure of circulation. The lungs never show voluminous emphysema, and indeed the earlier the death the greater is the serous edema in their substance. On the second day the fluid does not drip quite so freely from the cut surface as on the first, and toward the beginning of the third day the general aeration of the lung is everywhere greater, while relatively large islets of well-aerated and slightly emphysematous lung may be present between areas of edema or of collapse. This aerated condition appears at first in the lower lobes of the lungs where they are in contact with the diaphragm, while edema persists longest and is most profuse in the upper lobes.

A day later and no serous fluid at all escapes from the cut surface. At this date inflammatory complications tend to appear in a surface pleurisy, and areas of the lung are found to be slightly friable and entering into a condition of broncho-pneumonia.

It may be that cases of extensive and overwhelming edema succumb at once, while those in which on the second or third day larger islets of aerated lung alternating with edematous patches are seen, had from the beginning been in that state, so that they succumbed later than the completely edematous group because the injury to the lung was less. But the general evidence favors a more hopeful view, namely, that the edema fluid is rapidly absorbed from the second day onward, and that the later post mortems illustrate the stages in this recovery. The chief fact in support of this view is that patients who had been deeply cyanosed at first, with the usual signs of extensive pulmonary edema, and so asphyxiated as to be unconscious for a couple

of days, may yet recover so completely that eight or nine days after exposure to gas it is difficult to discover any physical signs of edema in the lung.

Symptoms:

217. **Onset.**— Upon exposure to chlorine alone, a man feels immediate respiratory distress. He coughs violently and speech is made impossible by his spluttering gasps. With the later forms of drift gas, the onset is slightly altered. There is some lachrymation. The throat feels gripped and the chest tight. Breathing is difficult but not impossible. Coughing develops a quarter of an hour or more later. Nausea and vomiting appear quickly, so that a man who was slow in getting protection may vomit inside his gas mask. Headache and throbbing sensations in the body are experienced.

**Development.**— Coughing and retching increase. The respiration becomes very hurried and labored, though shallow. The patient's face assumes a cyanotic hue; he may lose muscular power and consciousness and die in an hour or two. Those who survive longer show the following features:

Headache, pain behind the sternum and in the epigastrium. Extreme restlessness and anxiety, or a semicoma with a muttering delirium, from which as a rule they can be roused to answer questions. Varying cough, sometimes slight, sometimes reiterant with a croupous rattling from exudate in the trachea. There is practically no laryngitis. A cyanotic blueness in the lips and ears, which may accompany a flushed lividity of the face or the grayish-yellow pallor of collapse. Extremely rapid respiration, from 40 up to even 80 a minute, of a shallow type on a distended chest, and often marked by a jerking grunt of expiration. A pulse of about 100, which may rise to a higher rate and fall to a very low pressure in the gray examples of collapse. The skin is dry, and either hot or cold in correspondence with the state of collapse. Expectoration may be very slight, though in others there soon develops an abundant discharge of thin watery fluid, often streaked with blood, which simply flows from the mouth as the dying patient loses power to expel it. After death, the foam from this fluid may dry to a white efflorescence around the mouth. The percussion note is slightly flattened over the lungs behind, where the breath sounds are much weakened, but

otherwise unchanged in quality. Fine rales are heard behind and in the axillæ. There are no tubular breath sounds. In front there may be extremely little change beyond harshness in the breath sounds. The physical signs fail altogether to indicate the extent to which the lungs are damaged, for in any area examined there is always some aeration of the bronchioles and alveoli which suffices to produce relatively normal sounds on auscultation.

The color, the pulse, and the rate of respiration are the chief guides to prognosis.

**Progress.**— Four-fifths of the deaths occur in the first 24 hours. Very few succumb after the third day. A man, who at first seemed to be lightly gassed, may, toward the end of the first day, develop cyanosis and die; but from the end of the second day onward, there is no danger to be apprehended for the less grave cases. On the second day the sputum becomes less abundant, more viscous and yellow tinted. The dyspnea persists and the temperature is raised. If complications develop subsequently from infections of the raw respiratory tract, they will be shown by persistence of fever, by a purulent sputum, and by signs of broncho-pneumonic consolidation.

But as a rule the patient recovers rapidly after the third day, and at the end of a week he is fully convalescent. Cough, pain in the chest, which is often very severe beneath the rib margins, shortness of breath, loss of appetite with gastric pain, and general lassitude persist longest of the symptoms. There are no serious after results to be apprehended. A man who has been badly gassed requires a long rest; but the majority, if free from neurasthenic symptoms, are fit for light duty in a very few weeks, provided that they are allowed sufficient rest at first. The heart and circulation are severely strained by gas poisoning. Convalescents who show tachycardia must be carefully watched lest too heavy physical effort early in the first month of recovery induces further strain and lead to the condition of irritable soldier's heart, from which recovery will be long delayed.

**Rarities:**

218. **Brain.**— In some cases that died after two or three days of persistent cyanosis and unconsciousness the white matter of the brain was found to be peppered with tiny petechial hemorrhages. These are the direct outcome of the asphyxial state and have

little clinical significance. Large cerebral hemorrhages have, however, been noted, occurring on the first or second day in cases of plethoric cyanosis.

**Vascular obstruction.**— Occasionally the peripheral arteries to the limbs may become occluded. As a rule, the threatening gangrene clears up in these cases.

**Stomach.**— Petechial hemorrhages and a slight superficial ulceration are often seen post mortem over the inner surface of the cardiac fundus The stomach has occasionally at autopsy been found to be full of blood from an extension of this ulcerative process, but only in one case has death occurred with hematemesis. The gastric derangements, which generally persist during convalescence, are not of a type suggesting the result of an ulcerative process.

**Kidney.**— Clinical nephritis is rare, and its occurrence may in each case have been a chance coincidence.

## TREATMENT.

### General Considerations:

**Rest is the most important point of all in the general treatment of gas casualties.**

219. Men, and especially officers, should be warned beforehand that if lightly gassed they must refrain from moving about or shouting out orders. Physical strain after gassing may easily involve the loss of a life that might otherwise have been restored to the fighting line in a short time. The principle of attaining complete rest as soon as possible underlies the detailed advice for dealing with gas casualties that is given below, and is the reason for their detention at the casualty clearing stations. All kit that hinders the play of the respiratory muscles, especially belts and suspenders, should be undone. Sleep brings improvement, and restless excited cases should be quieted by morphia. It is important that arrangements should be planned beforehand at each casualty clearing station so that even a large number of gas casualties can be handled with such discipline and control as will at once introduce a sense of order and quietude, and by separating those who are more dangerously ill from the remainder, enable the less severe cases to get to sleep at once.

Next in importance to rest comes the use of oxygen, protection from cold, special stimulants or drugs, venesection, and methods for removing serous exudate from the lungs.

Bronchial spasm does not seem to be a serious danger with the present form of cloud gas. Life or death is decided by the degree of pulmonary edema and asphyxia with circulatory failure. The edema fluid tends to be absorbed quickly, and if the patient can be carried alive through the first two days, he should recover. Precautions in the meantime need to be taken to lessen the chance that secondary respiratory infections may develop as a later complication.

**Oxygen,** if rightly administered, will generally lessen cyanosis, and therefore improve the patient's chance of life. But the lung surface available for absorption is so small that the oxygen must be given in high concentration. The simple admixture with air obtained by open flow from a funnel or a tube placed in the patient's mouth is useless, and since it wastes valuable oxygen it should be forbidden. Given as the pure gas from a bag with a valved face mask, as described in Treatment at Casualty Clearing Stations (see par. 222), say for 3 or 4 minutes every quarter of an hour, an oxygen cylinder of 20 feet capacity will last about 4 hours. By this means life can undoubtedly be saved in some of the apparently desperate cases. The administration must be continued night and day, so as to hold cyanosis in check. The consumption of oxygen by this method is so large that all care must be taken to economize cylinders, the provision of which, under active service conditions is necessarily limited by considerations of transport. Many casualties are so severely poisoned that their condition is seen in the first few hours to be hopeless. Some selection of the cases for oxygen treatment must therefore generally be made, and it is especially with the intermediate group who are surviving into the second day that oxygen has the best chance of acting with ultimate advantage. It is quite unnecessary to use it for relatively mild cases. Deep cyanosis, whether of the congestive or pallid type, is the indication of need, and the lividity can always almost be lessened if the face-mask is properly applied.

The subcutaneous injection of oxygen is useless.

**Warmth** is needed in many of the severe cases, especially at the outset when they are collapsed and their skin is cold. To attain this, it may even be necessary to transfer them temporarily indoors. Otherwise the fullest supply of fresh air is needed for all cases. When outside, care should be taken to

protect against chill, which might lead to a subsequent bronchopneumonia.

**Special stimulants and drugs.**—Ammonia is very useful as an inhalation from the small ampoules supplied. It is necessary to warn orderlies that these ampoules are to be held at some distance from the patient's mouth, and that their use should not be persisted in where they seem to aggravate the difficulty of breathing. The action is more as as stimulant than in chemical antagonism to the chlorine.

Brandy and water is a good restorative when given in small sips. Cases of gray collapse with a rapid pulse of poor tension do not react well to stimulant drugs and are almost hopeless when they develop this condition in the first day. Pituitrin, 0.5 cc. hypodermically every three hours, gives some aid to a failing heart. The benefit of digitalin and strychnine is more doubtful.

**Venesection** gives real relief to men with deep cyanosis and a full pulse. The headache is lessened, the breathing feels easier, and the patient may soon fall into a sleep that conserves his strength. It appears to be harmful in collapsed cases with a poor pulse, and it should not be postponed until the patient passes into this dangerous state.

**Methods for aiding the discharge of exudate from the lungs.**—(1) Emetics have been given at various times in the hope that the lungs would be partly emptied in the act of vomiting. The effort is very exhausting and the results do not justify the treatment in late cases. But in the first few hours, before the patient is gravely ill, vomiting is probably good and retching may be encouraged by simple means. Later, it is better to try and allay gastric pain or retching by the use of drinks with sodium bicarbonate. Beef tea is not to be recommended in view of the possibility of slight gastric ulceration.

(2) In the first day, if there is much fluid expectoration, good results may be obtained by postural treatment, such as by turning the head of the patient sideways and then raising the foot end of the stretcher two or three feet, or even higher, for a few minutes at a time.

(3) Schafer's artificial respiration has occasionally proved of service in expelling fluid from the chest, but it is necessary to watch its effect on the patient very closely lest disaster ensue.

(4) Expectorants in large doses, such as 10 or 15 grains of ammonium carbonate, are probably harmful at the beginning, for they will cause nausea and an irritant cough which will interfere with sleep and may augment the tendency to disruptive emphysema of the lungs. Patients who are not seriously ill should be given a simple mixture such as amm. carb. gr. v and vin. ipecac. m. x. 6 hourly on the second day. Later treatment might comprise ordinary medicinal measures such as potassium iodide, atropine, steam tents with tincture benzoin compound, etc., for symptoms as they arise.

## PART 4.—REGULATIONS FOR TREATMENT OF GASSED CASES.

### Treatment by Regimental Medical Officers :

220. 1. All ranks should be warned of the need for seeing that the gas masks of wounded men are kept properly in position until the danger from gas has passed away, and also of the importance to lightly gassed cases of remaining absolutely quiet.

While the gas cloud is concentrated, all ranks should refrain as far as possible from movement, so that they may breathe slowly and keep the current of air through the gas mask at a low velocity.

2. After the order has been given for removal of masks, ammonia inhalations from the capsules should be given by stretcher bearers to all gassed men with difficulty in breathing, but their use should not be persisted with in those special cases where the ammonia seems to increase the discomfort of the patient.

3. Clothing over the chest should be loosened, the suspenders and belt undone in front and equipment removed.

4. Vomiting at first is beneficial and it may be encouraged by drinks of tepid water, either alone or with salt (1 tablespoonful to half a pint or more of water), and the back of the throat should be tickled shortly after the drink has been taken.

5. Experience has shown that atropine is of no use in the early stages of gas poisoning.

6. All gas casualties must be evacuated as soon as possible to dressing stations. All except the lightest cases should, as far as possible, be evacuated lying down, and walking cases should be warned to seek assistance in going back along the trenches so as to avoid physical effort as much as possible. Special attention

should be paid to men who complain of feeling collapsed, though they show no manifest features of having been gassed, since these may develop later the serious form of delayed poisoning.

Rest is the one point that is essential from beginning to end of the treatment of gas casualties. Gassed men should not be allowed to carry their own equipment back from the trenches. It is suggested that arrangements for the disposal of kit should be made regimentally in advance.

**Treatment in Dressing Stations :**

221. 1. Casualties should be kept lying down in the open air, so far as weather permits. Suspenders must be undone and clothing over the chest loosened, so as to give freedom for breathing.

2. Ammonia inhalations should be given. Experience has shown that atropine injections are of very doubtful value.

3. If the patient still feels inclined to vomit, he may be given tepid drafts of salt and water, and the back of the throat tickled.

4. Restless cases, if fully conscious, may be given one quietening injection of one-fourth grain morphia. The time of injection and the dose must be recorded on the diagnosis tag.

5. Severe cases fall into two groups : The "collapsed" with a poor pulse and leaden gray tint and the "cyanotic" or "blue" with a full pulse and general asphyxial lividity.

6. Collapsed cases may be retained at the dressing station for a short time, and their state of collapse combated by stimulants such as external warmth, hot drinks, brandy, pituitary extract, or other drugs. If there is much fluid flowing up through the mouth, the feet of the stretcher should be raised to a height of about 4 feet and the patient's head turned slightly sideways. This position should not be maintained for more than a few minutes and it should be abandoned if it aggravates the cyanosis or fails to increase the discharge of fluid.

7. Blue cases of severe cyanosis require continuous treatment with oxygen in high concentration. They should therefore be evacuated as soon as possible to the nearest casualty clearing station or field hospital, unless special apparatus for their treatment is available at the dressing station. If there is unavoidable delay before transference the treatment recommended at the casualty clearing station, paragraphs 7 and 8, should be tried.

8. All cases except the mildest should be evacuated lying down, and the severe cases, with the exception of those of grave collapse, should be transferred first of all.

**Treatment at Field Hospitals and Casualty Clearing Stations:**

222. 1. Serious cases should at once be separated from the slight, so that the latter may lose their anxiety and get to sleep.

2. Ammonia inhalations may be useful on admission at any time up to 24 hours after exposure to gas.

3. Open air treatment is best, if the weather permits, and complete rest is essential for the first two days. The clothing and suspenders should be loosened, and the worst cases should be undressed and put to bed wherever this is possible.

No patient should be allowed to leave his bed or stretcher for any purpose whatsoever.

4. Restless cases, if not unconscious, may be quieted by one injection of one-quarter grain morphia.

5. Collapsed cases should be treated with warmth and stimulants as described in dressing station 6, and oxygen should be used in addition. Atropine is harmful to these patients.

6. Attention should be paid to the posture of unconscious cases, both to aid discharge of any fluid that may be escaping from the lungs and to avoid injury to nerves or skin by pressure, e. g., from a clasp knife or the edge of the stretcher, if the patient is not undressed and in bed.

7. Cyanosis can be lessened by the administration of oxygen in high concentration. For this purpose the flow from a simple funnel or a tube in the mouth in inadequate and wasteful of the gas. An apparatus should be used with a valved face mask, such as that for nitrous oxide anesthesia, the valves being so set that the patient breathes in oxygen from the bag and breathes out into the open air. The treatment should be continued hour after hour with brief intervals until the edema of the lungs clears up. Cases may recover after being cyanosed and unconscious for two days.

8. Venesection, performed slowly, to the amount of 15 or 20 ounces may be of use to "blue" cases if practiced early and before the pulse begins to fall.

9. **Expectorants.**—Drugs such as ammonium carbonate and vinum ipecac are recommended for use in expectorant doses from the second day onward.

10. The diet should be light and simple. Measures should be taken to open the bowels.

11. As far as circumstances permit, no case should be evacuated to the line of communication until definite cyanosis or serious symptoms have disappeared. A note should be sent down with those cases which have passed through a condition of gravity, so as to guide the medical officer on the line of communication as to the future treatment of the case.

**Lines of Communication :**

223. The methods of treatment advised at casualty clearing stations are applicable for use in hospitals on the line of communication when circumstances necessitate the early evacuation of cases.

A very large proportion of the casualties sent to the base as "gassed cases" are likely to become fit for duty after a short rest. Wastage by transfer to home territory is to be avoided, and medical officers should exercise the greatest care in selecting cases for evacuation to home hospitals.

As a rule, only cases in which there was a clear history of grave cyanosis or collapse, or in which secondary infections of the respiratory tract have developed, should be sent farther than the base. It may be taken for granted that all casualties which had been detained in a casualty clearing station for five days were of a serious nature, whatever their condition on arrival at the base hospital.

**Rest stations.**— Rest, with the possibility of lying down on a bed at any time of the day, must be provided during the first two or three weeks for all cases except the very mildest. Arrangements should, when possible, be made at the base to give accommodation, if the patients cannot be retained in the main hospitals, for an easy life of this nature which is not permitted in the usual routine of convalescent depots.

**Convalescent depots.**— Gas casualties, who show neurasthenic or cardio-vascular weakness after three weeks' treatment at the depot, should be transferred to home hospitals.

## PART 5.— INDEX TO DRUGS WHICH HAVE AT VARIOUS TIMES BEEN USED.

224. **Ammonia.**— The benefit of occasional inhalations of ammonia during the first day is universally admitted. Spiritus

ammon. aromat. in 4 cc. doses with plenty of water is useful as a direct stimulant, but it does not ease breathing in the same way as does vapor.

**Ammonium carbonate.**—In large doses of gr. xv as an emetic has proved harmful and never done good in the early stages. As an expectorant it should only be used in small doses of gr. v.

**Apomorphine.**—In hypodermic doses of gr. 1-10 has been recommended as an emetic. The vomiting often fails, the drug is depressant, and its use had never proved to be of the least value.

**Atropine** has been supposed to be useful in the early stages of poisoning, both to relieve bronchial spasm and to check the secretion of edema fluid. The drug has been extensively tried, both in the French and British medical services, and no conclusive evidence of such benefit has been found. On the other hand, atropine does tend to accelerate the heart beat, and a result of this nature is an actual disadvantage to an asphyxiated patient. Its use in the first two or three days should therefore be discontinued.

**Camphor** in conjunction with ether forms a useful stimulant in cases of collapse. The Japanese in the Russian War used as a general stimulant a hypodermic injection of 10 to 15 minims of camphor 1 part, ether 4-5 parts, olive oil 4 parts. It is possible that this might also be of value in cases of gas poisoning associated with collapse.

**Digitalin,** grain 1/100, hypodermically, has so slight an action that it probably is not worth using in the two or three critical days of acute pulmonary edema.

**Ipecacuanha** has been recommended as having a specific action in promoting the absorption of edema fluid. For this purpose, 20 to 30 minims of the Vinum have been given two-hourly. Nausea and emesis are not aimed at. The evidence as to its action in this sense is inconclusive, though it is useful in smaller doses as an ordinary expectorant. The drug should not be given as an emetic, because it produces depression.

The extractive, **Emetine,** has been tried hypodermically in repeated doses of gr. 1-3 and without any apparent benefit whatsoever.

**Morphia** is most useful as a sedative and may be given even to deeply cyanosed patients for extreme restlessness. The dose should not be large, gr. ¼, followed, if need be by gr. 1-6, or 15 to 20 minims of tinct. opii.

**Phenacetin** and **Aspirin** have been given to relieve the headache caused by mine-gas poisoning, and they were found to produce a dangerous state of collapse in these patients. It is therefore inadvisable to use them for the headache that follows the inhalation of cloud gas.

**Pituitrin** 0.5 cc. into the muscles or hypodermically increases cardio-vascular tone for a short time and gives aid to a failing heart. If a second injection is given 15 to 20 minutes after the first, it may cause the pressure to fall. An interval of three hours should be observed if the dose is repeated.

**Sodium lactate** taken by the mouth every four hours in 2 drachm doses of a 50 per cent solution has been employed with a view to augmenting the alkaline bases of the blood, fixing some of the excess of carbon dioxide, and thereby tending to lessen the rate of respiration. The main features of gas poisoning are not influenced by this method of treatment.

**Sparteine** has erroneously been supposed to be a cardiac tonic and a useful drug in the place of digitalin. Actually it is a poison which slows and weakens the heartbeat.

**Strychnine,** one-thirtieth grain, may be employed in the early stages of pallid collapse.

## PART 6.—NITROUS FUMES, LACHRYMATORS, HYDROCYANIC ACID, CARBON MONOXIDE.

### Nitrous Fumes:

225. Though no cases of nitrous fumes poisoning have hitherto been recorded, the possibility of their occurrence owing to exposure to the fumes of burning explosives should not be lost sight of.

The great danger of nitrous fumes arises from the fact that in the concentrations usually met with there is comparatively little irritation of the eyes or upper respiratory passages, and a man working in such an atmosphere will not recognize its deadly nature. Air which contains enough nitrous fumes to cause feelings of irritation in the nose or air passages must be regarded as very dangerous. Nitrous fumes are very soluble in water, and the gas may be readily removed from the atmosphere by means of a water spray, whilst a few folds of a handkerchief or a towel wetted with water and tied over the nose and mouth will give efficient protection in the absence of a mask. The possibility of

the simultaneous occurrence of carbon monoxide in atmospheres containing nitrous fumes must be remembered.

Owing to the delay in the onset of serious symptoms, it is essential that any man who is suspected of having been exposed to nitrous fumes should be sent to hospital with as little delay as possible and detained there for 24 hours for observation.

**Pathological changes.**— The pathological changes found post-mortem in a fatal case of nitrous-fumes poisoning are identical with those described above as characteristic of chlorine poisoning. If the concentration of nitrous fumes to which the case has been exposed is very high, the blood may be somewhat chocolate colored owing to the formation of methaemoglobin.

**Symptoms.**— If the gas is in very great concentration, rapid fatal asphyxiation takes place, but in the concentrations that are usually encountered, the characteristics which distinguish this from chlorine poisoning are the slightness of the initial symptoms due to irritation of the upper respiratory passages and delay in the onset of acute pulmonary edema.

The typical sequence of events is —

(1) Slight irritation of the nose and throat, feeling of constriction of the chest, headache and slight smarting of the eyes and coughing while actually exposed to the fumes.

(2) On leaving the poisonous atmosphere a latent period during which the case may, and usually does, feel quite well and has no hesitation in taking a meal.

(3) The sudden onset after four to eight hours of acute symptoms. These commence with marked and increasing distress in breathing, coughing, and often severe pain in the chest. The cough is at first dry, and auscultation may reveal no moist sounds. This condition is speedily followed by the urgent signs of acute pulmonary edema which have been already detailed under chlorine poisoning (par. 214), and death may ensue in a few hours.

**Treatment.**—When once pulmonary edema has developed, the treatment should follow the lines already laid down for chlorine poisoning (par. 219). The experience of medical officers attached to mines on the Rand, where nitrous fumes are frequently met with during blasting operations, points to the value of inducing emesis as soon after exposure to the fumes as possible, followed by a dose of such a stimulant as spir. ammon. aromat. A case

of nitrous-fumes poisoning should be under medical observation at the time when acute pulmonary edema is likely to develop and a venesection of from 15 to 20 ounces should be made as soon as there is the slightest sign of its onset. Venesection must not be delayed until the patient's condition is grave and the stage of lividity has been reached, or it will be useless.

**Lachrymators :**

226. Hitherto, no serious cases of poisoning have occurred as the result of exposure to the effects of shells containing substances employed merely on account of their lachrymatory properties.

The immediate effect of a trace of the vapor of such a lachrymator as benzyl bromide in the air is to cause profuse watering of the eyes, accompanied by smarting. If the concentration is somewhat greater, the smarting and pain in the eyes may become intolerable, so that it is impossible to keep the eyes open. The smarting and watering of the eyes will be quite sufficient to put a man completely out of action, because he is incapable of seeing, but protection of the eyes is easily obtained by the use of goggles.

With increasing concentrations of the vapor, other effects show themselves. The vapor is irritant to the lungs and upper respiratory passages and this leads to a burning sensation in the throat and coughing. Nausea is often present and not infrequently leads to vomiting, accompanied, it may be, by pain in the epigastrium. If it is impossible to withdraw from exposure to the fumes, slight confusion of mind and torpor may show themselves.

Under ordinary conditions the symptoms do not develop further, and though the case may become somewhat collapsed as a result of the vomiting and general discomfort, this is only temporary, and within an hour or two after getting into air free from the lachrymator there may be very little amiss with the man. The nausea and irritation of the throat soon pass off, though the eyes may remain sore for some little time, and even after the lapse of 12 hours redness of the eyelids and slight injection of the conjunctiva may still be evident. There are no subsequent toxic effects and the case will be fit for duty as soon as the primary effects have passed off.

It must not be forgotten that some of the acute lung irritants are also extremely powerful lachrymators, and that such substances may be used with a view to securing a double effect, viz., immediate blinding and simultaneous intense toxic effect on the lungs. In order to secure such an effect it is essential that the substance used shall be gaseous or shall vaporize with sufficient rapidity to attain a high enough concentration in the air to produce these intense toxic effects. Lachrymators such as benzyl bromide, which are liquid at ordinary temperatures, vaporize too slowly to produce such a concentration, and the symptoms caused by a lachrymator of this type, therefore, very rarely attain a degree of severity greater than those described above in detail.

The smell of benzyl bromide when in great dilution suggests the flavor of mustard and cress. Lachrymators as a rule have aromatic, pungent odors.

**Hydrocyanic Acid :**

227. When in sufficient concentration this gas acts as a very rapid and sometimes almost instantaneous poison, affecting directly the central nervous system.

**Symptoms.**—These follow one another in rapid sequence : Giddiness, confusion, headache, indistinct sight, palpitation and pain in the chest and over the heart. Labored respiration. Unconsciousness, convulsions, failure of the respiration and finally of the heart. In large doses, immediate unconsciousness, dilatation of the pupils, a few gasping respirations, and death with or without convulsions.

The gas paralyzes the respiratory center very quickly, and with small fatal percentages the heart may continue to beat for a brief time after the respiration has ceased. With larger concentrations the heart may be stopped almost at once by the direct action of the poison.

When death is caused by inhalation of hydrocyanic-acid gas, it is unlikely that the smell of the gas will be detected at autopsy, as may be the case when poisoning is due to the ingestion by the mouth of a large dose of prussic acid.

**Treatment.**—Immediate treatment is the only measure of any avail if a man falls unconscious from hydrocyanic-acid poisoning. The case must be at once dragged into fresh air, and if the respiration has stopped, or is very weak and gasping, artificial

respiration must be instantly applied by Schafer's method. It is possible by this means to resusticate a case, and if this is so recovery will be perfect. Cold water may be splashed on the face and chest and friction applied to the limbs, but time should not be wasted on these measures before commencing artificial respiration. The same immediate treatment holds good for any other gas that causes rapid unconsciousness from its effects on the central nervous system.

**Carbon Monoxide :**

228. The great danger of carbon monoxide arises from the fact that the gas is colorless, odorless, and nonirritant, and that the onset of symptoms is so insidious that very often the first warning that a man may receive is failure in the power of his limbs which will prevent him from retreating into safety. Neither the box respirator nor other masks give protection against carbon monoxide; protection can only be attained by the use of special oxygen breathing apparatus.

**Pathological changes.**—At the autopsy, the blood may be red in color instead of dark if there is a considerable degree of saturation of the hemoglobin with carbon monoxide. If the case has continued to breathe for some time after reaching an atmosphere free from carbon monoxide, this gas will have been partly or entirely displaced from the hemoglobin and the blood after death will have its normal color.

The simplest method of detecting the presence of carbon monoxide in blood is to compare the color of a dilute solution of the suspected blood with a similar solution of normal blood. Take a drop or two of blood from the finger of a normal person and dilute it in a test tube very considerably with water (a one-half of 1 per cent solution is a convenient strength), so that when examined by transmitted daylight the color of this solution is a reddish-yellow. Then take a drop or two of the suspected blood and dilute it similarly with water, so that the depth of color of the solution is the same as that of the solution of normal blood when both are viewed by transmitted light. On examining the quality of the color it will be found that the solution made with the suspected blood, if it contains carbon monoxide hemoglobin, is definitely pinker than that made with the normal blood, though it will not have the full pink tint of the same normal blood solu-

tion if the latter be shaken with coal gas so as to saturate it quite completely with carbon monoxide.

The lungs show no abnormal changes in cases of rapid death. Small punctate hemorrhages may be found in the white matter of the brain and sometimes ecchymoses in the meninges if the case has been exposed to a concentration of carbon monoxide sufficient to cause prolonged unconsciousness.

**Symptoms.**— Except with very massive doses, when loss of consciousness is very rapid, the symptoms develop very gradually, as the gas is only absorbed slowly. If a man is at rest in a concentration of the gas of 1 part in 1,000 it will take about two hours before definite giddiness appears and he will not be definitely disabled until the lapse of two and one-half hours. The rate of absorption of the gas is much quickened when the breathing is deepened during muscular exercise and the exercise also leads to great accentuation of the symptoms. With a concentration of 2 parts in 1,000 a man will be seriously affected in half an hour if he is performing a moderate amount of muscular work, and this concentration may prove fatal with prolonged exposure.

Small animals are far more quickly affected by carbon monoxide than man is, owing to the natural great ventilation of their lungs and the rapidity of their circulation. A mouse or a canary will show definite symptoms of carbon monoxide poisoning in a tenth of the time that a man will. If small animals are used to give an index of the presence of carbon monoxide in a suspected atmosphere, it must be remembered that though they show symptoms long before a man feels any effects, the man will in the end be reduced to the same condition as the animal, and he ought therefore to leave the dangerous atmosphere directly the animal shows signs of being affected, unless he is protected by special apparatus.

The first sign that tells a man that something is amiss is very frequently a feeling of loss of power in the limbs. Giddiness, slight confusion of mind, and breathlessness and palpitation on the least exertion also show themselves. The confusion of mind and loss of power in the legs frequently preclude a man from withdrawing from danger, even though he is dimly aware that safety is only a few yards distant. The failure of power in the limbs and mental confusion rapidly increase and the man may

appear drunk, shouting incoherently, laughing, swearing, or praying. Apathy and complete helplessness supervene, and failure of the intellectual powers gradually passes into complete unconsciousness, which may finally terminate in a painless death.

The symptoms may remain stationary at any stage, since the degree of saturation of the hemoglobin with carbon monoxide reaches a final end point which is determined by the relative concentrations of the carbon monoxide and the oxygen which are simultaneously trying to combine with the hemoglobin.

Even in cases of mild gassing with carbon monoxide, a severe headache accompanied by nausea is very likely to develop.

**Treatment.**— The symptoms detailed above are due to the gradual diminution of the oxygen-carrying power of the blood and the exposure of all the organs of the body to increasing want of oxygen. It is clear that any increase in the oxygen demands of the body is to be avoided, and any man, therefore, who shows definite signs of gassing should be carried to a place of safety. If he attempts to walk himself he is quite likely to fall down unconscious. When a moderately gassed case reaches fresh air he sometimes falls unconscious, while other cases may commence to shout and struggle, in which case their movements need to be controlled.

Any case showing definite symptoms should be removed as soon as possible to some place of safety where he can remain at rest for an hour or two before evacuation. Rest is essential.

As carbon monoxide hemoglobin is a dissociable compound, the carbon monoxide is gradually driven out of its combination with hemoglobin by the oxygen of the air as soon as an atmosphere free from carbon monoxide is reached. In fresh air it will take an hour or two before the blood is entirely freed from carbon monoxide, but the process can be rendered five times as rapid by giving the patient pure oxygen to breathe. It is important therefore to begin the administration of oxygen by some efficient method as soon as possible after the case has been removed from the poisonous atmosphere. A suitable method has been described under chlorine poisoning (par. 214) and the oxygen apparatus that is kept at mine rescue stations is also most efficient. Administration of oxygen should be kept up as continuously as possible for half an hour to an hour, depending on the severity of the symptoms. It should be remembered that if a case can be kept

at rest for half an hour and oxygen administered immediately after being removed from the poisonous atmosphere, he will be in far better condition to travel than if he has to be removed to a more distant point. If the breathing is very shallow, administration of oxygen may be combined with artificial respiration.

Collapse should be combated by external warmth and by friction of the limbs.

In chlorine poisoning the pulmonary edema and damage to the lungs and the consequent interference with the gaseous exchange taking place between the blood and the air in the lungs persist for some time and may necessitate the administration of oxygen for several days. In carbon monoxide poisoning the structure of the lungs is not interfered with and oxygen is administered with the deliberate intention of accelerating the discharge of carbon monoxide from the blood. When once this has been accomplished, i. e., after half an hour's or an hour's administration, there is no need to continue the oxygen administration, as the oxygen-carrying power of the blood has now become normal again. Any symptoms that persist are due to effects that were produced while the blood was charged with carbon monoxide and are unlikely to be influenced by oxygen administration when once the carbon monoxide has been got rid of. Further oxygen administration is therefore required only if cyanosis begins to develop subsequently from secondary cardiac or respiratory failure.

Cases of carbon monoxide poisoning have been known to recover, even when they have remained unconscious for so long as 48 hours after removal from the poisonous atmosphere. In cases that have been severely gassed the possibility of subsequent cardiac dilatation must not be lost sight of, and cases of severe gassing should not be returned to duty until confidence is felt that the circulation has recovered from the strain. As a result of damage to the nervous system while the blood was charged with carbon monoxide, paralysis of single muscles or a groups of muscles, or different forms of mental disturbance are sometimes found as sequelæ.

### Need for Further Investigation:

229. Knowledge on the various points discussed in this pamphlet is still far from being stable. Medical officers are there-

fore asked to assist by making further observations and at once writing down notes on any of the following particulars, about which chance may enable them to supply useful information. Such notes should be forwarded to the division surgeon.

1. Smells of the gas. This may be musty, pungent, aromatic like lilac, garlic, mustard and cress, bitter almonds, and so on.

2. The symptoms in gassed men, especially those of onset, when they are in any way remarkable or differ from those described for cloud gas in this pamphlet. All points not observed by the medical officer himself should be subjected to careful cross-examination.

3. The findings at autopsy of very early cases of gas poisoning with an account of the manner of death.

4. The value of various methods of treatment of severely gassed cases, with control observations where possible.

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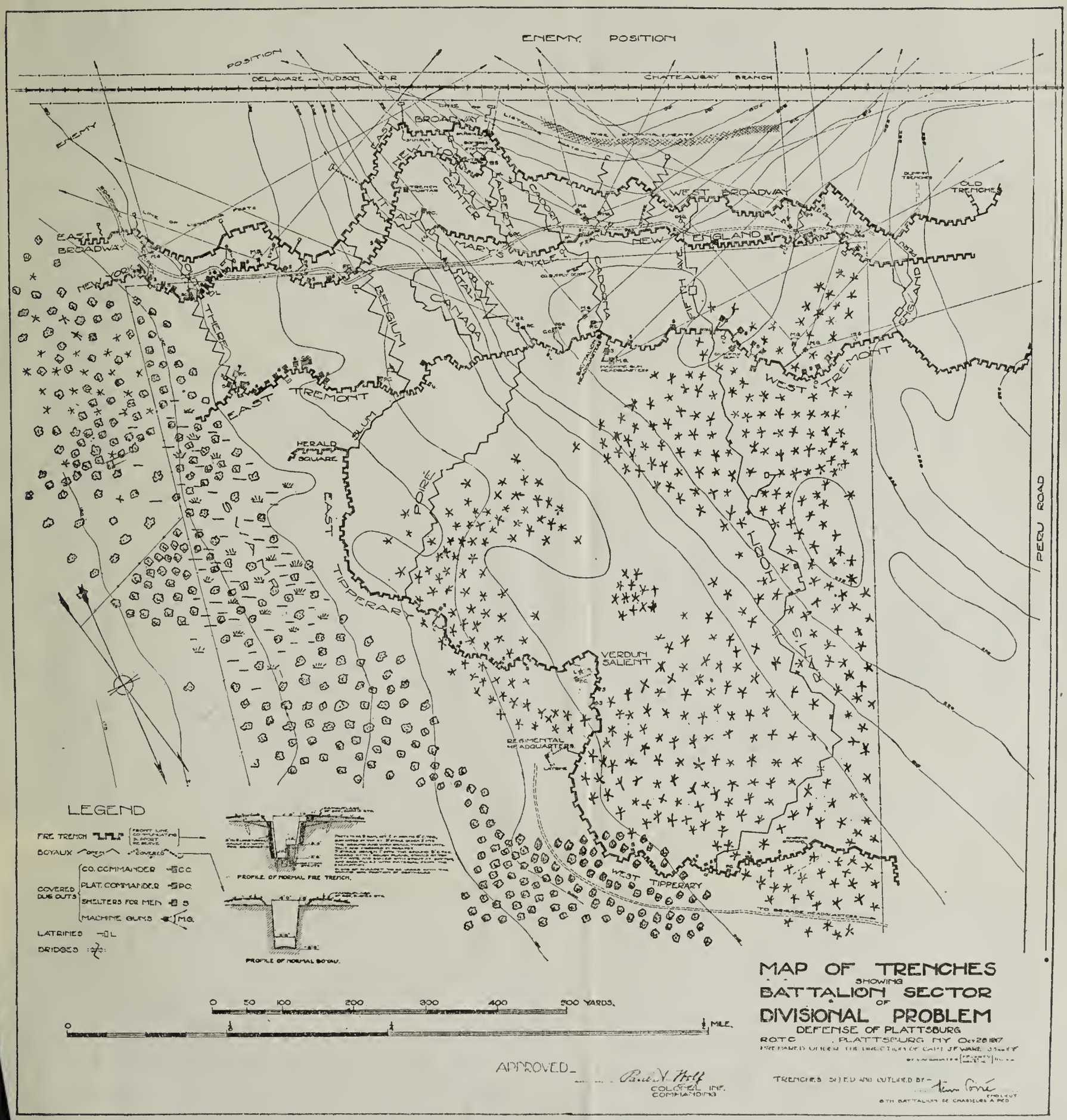
ENEMY POSITION
POSITION
DELAWARE — HUDSON R.R.
CHATEAUGAY BRANCH
ENEMY
EAST BROADWAY
NEW YORK
WEST BROADWAY
OLD TRENCHES
NEW ENGLAND
MARY'S ANKLE
CANADA
BELGIUM
ITALY
CADORNA
FIFTH AVE.
EAST TREMONT
WEST TREMONT
HERALD SQUARE
SLUM
POIRÉ
EAST TIPPERARY
VERDUN SALIENT
REGIMENTAL HEADQUARTERS
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COVERED DUG OUTS
CO. COMMANDER
PLAT. COMMANDER
SHELTERS FOR MEN
MACHINE GUNS
LATRINES
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PROFILE OF NORMAL BOYAU.
0 50 100 200 300 400 500 YARDS.
0 1/8 1/4 1/2 MILE.
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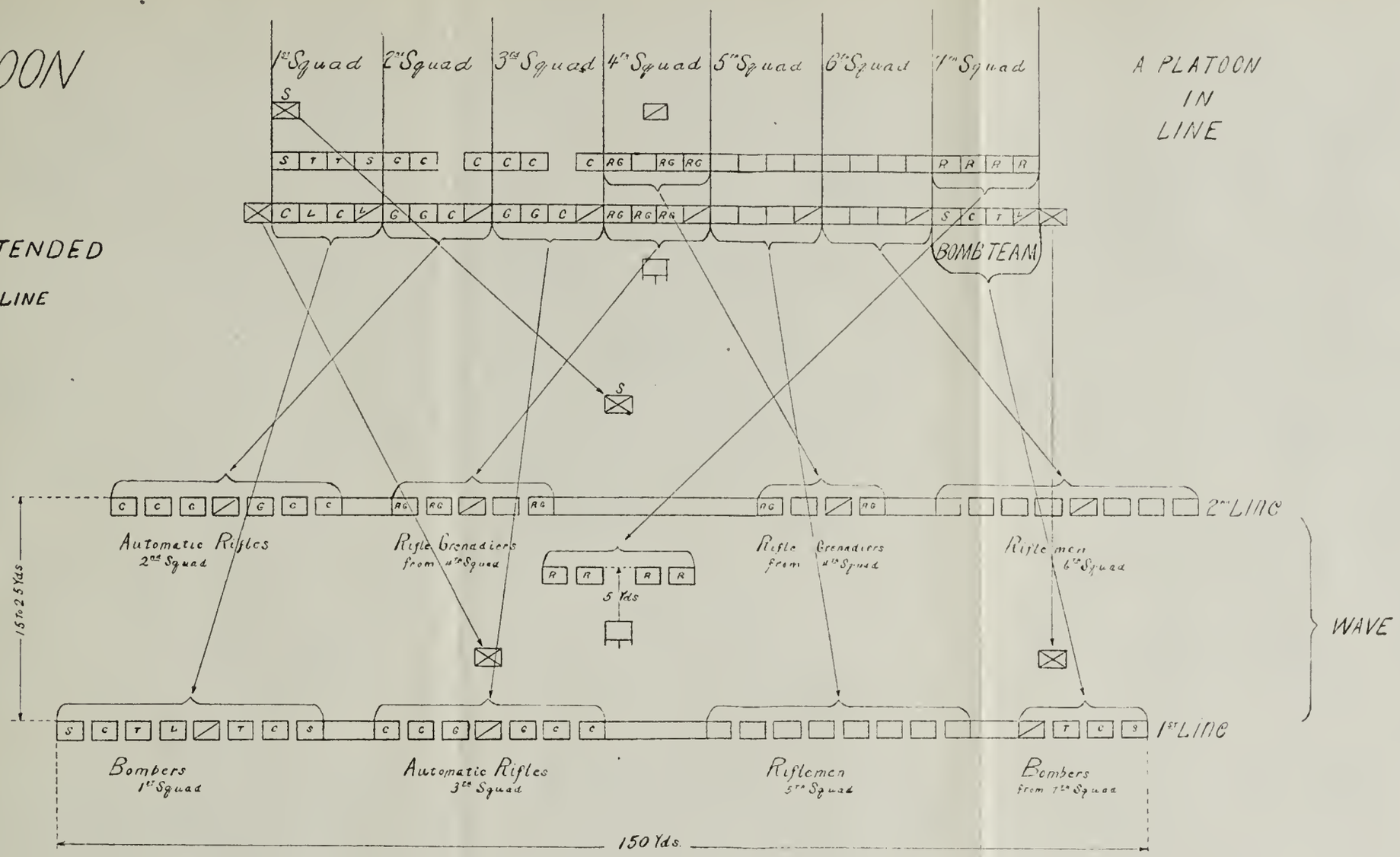
SHOWING
BATTALION SECTOR
OF
DIVISIONAL PROBLEM
DEFENSE OF PLATTSBURG
R.O.T.C. PLATTSBURG NY Oct 28 1917
APPROVED
COLONEL INF. COMMANDING
TRENCHES SITED AND OUTLINED BY
ENDICUT
6TH BATTALION DE CHASSEURS A PIED

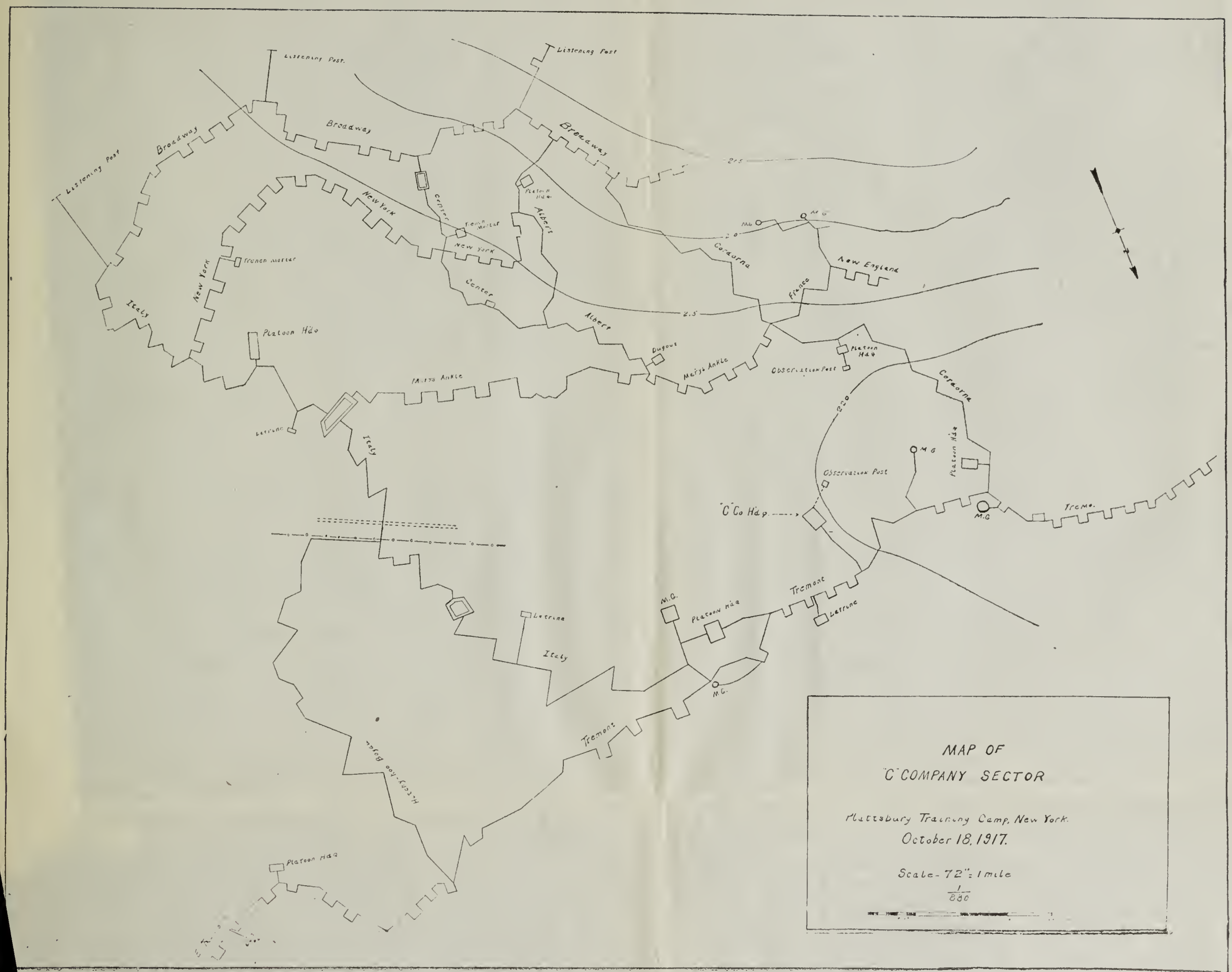
# PLATOON FROM LINE TO DOUBLE EXTENDED SKIRMISH LINE




NOTE: In deployment
1st - 3rd - 5th on first line
2nd - 4th - 6th on second line
7th on 1st line and intermediate line

Plate No. 26.

Plate #15




MAP OF
"C" COMPANY SECTOR

Plattsbury Training Camp, New York.
October 18, 1917.

Scale - 72" = 1 mile
$\frac{1}{880}$

Series A.

TABLE 7 — RIFLE COMPANY, INFANTRY REGIMENT.

**Maximum Strength**

Corrected to October 18, 1917

| 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | One Platoon | | | | | | | | |
| 1 | Units | Headquarters. | Platoon Hq. | 1st Section *n* (Hand Bombers) | 2nd Section *o* (Rifle Grenadiers) | 3d Section (Riflemen) | 4th Section *m* (Automatic Riflemen) | Total Platoon | Four Platoons, 1st to 16th Sections | Total Company Hq. and 4 Platoons | Remarks |
| 2 | Captain | 1 | | | | | | | | 1 | |
| 3 | First Lieutenants | *a*1 | *b*1 | | | | | | 2 | 3 | |
| 4 | Second Lieutenants | | | | | | | | 2 | 2 | (*a*) Senior first lieutenant, second in command. |
| 5 | Total Commissioned | 2 | 1 | | | | | | 4 | 6 | |
| 6 | First Sergeant | 1*p* | | | | | | | | 1 | (*b*) 1st and 4th Platoons commanded by first lieutenants; 2d and 3d Platoons commanded by second lieutenants; Additional officers in Regular Army from Reserve Corps or National Army. |
| 7 | Mess Sergeant | 1*r* | | | | | | | | 1 | |
| 8 | Supply Sergeant | 1*r* | | | | | | | | 1 | |
| 9 | Sergeants | | *c*1*pr* | | | 1*r* | 1*pr* | 3 | 12 | 12 | (*c*) Assistant to platoon commander. |
| 10 | Corporals | *g*1*r* | | 2*pr* | 2*pr* | 2*r* | 2*pr* | 8 | 32 | 33 | (*d*) To be distributed as needed. |
| 11 | Cooks | 4*r* | | | | | | | | 4 | (*e*) For replacement. |
| 12 | Mechanics | 4*r* | | | | | | | | 4 | (*f*) Automatic-rifle gunners. |
| 13 | Wagoners | *k*5 | | | | | | | | | (*g*) Company Clerk. |
| 14 | Buglers | 2*p* | | | | | | | | 2 | (*i*) Company agents and signalmen. |
| 15 | Privates, 1st Class | *i*4*r* | | 1*r* 4 3*pr* | 1*r* | 6*r* | *f*4*p* | 15 | 60 | 64 | (*k*) From supply company, not included in total. |
| 16 | Privates | | *s*4*r* | 6*r* | 6*r* | 8*r* | 8*r* | 32 | 128 | 128 | (*L*) Includes 8 rifles for automatic gunners not acting as such. |
| 17 | Total Enlisted | 18 | 5 | 12 | 9 | 17 | 15 | 58 | 232 | 250 | |
| 18 | Aggregate | 20 | 6 | 12 | 9 | 17 | 15 | 58 | 236 | 256 | (*m*) 4 automatic rifle teams, each consisting of 1 gunner and 2 carriers; 1 corporal for each two guns. |
| 19 | Mules, draft | *k*16 | | | | | | | | | |
| 20 | Carts, ration, 2-mule | *k*1 | | | | | | | | | |
| 21 | Carts, water, 2-mule | *k*1 | | | | | | | | | (*n*) 3 bomber squads, each consisting of: 1 leader, 1 thrower, 1 carrier, and 1 scout, (3 pistols for throwers). |
| 22 | Kitchens, rolling, 4-mule | *k*1 | | | | | | | | | |
| 23 | Wagons, combat, 4-mule | *k*1 | | | | | | | | | (*o*) 6 rifle grenadiers and 3 carriers. |
| 24 | Wagons, ration and baggage, 4-mule | *k*1 | | | | | | | | | (*p*) Armed with pistol only. |
| 25 | Bicycles | 2 | | | | | | | | 2 | (*r*) Armed with rifle only. |
| 26 | Grenade-dischargers, rifle | *e*6 | | | 6 | | | 6 | 24 | 30 | (*pr*) Armed with pistol and rifle. |
| 27 | Knives, trench | *d*40 | | | | | | | | 40 | (*s*) Runners. |
| 28 | Pistols | 5 | 2 | 5 | 2 | | 7 | 16 | 64 | 69 | |
| 29 | Rifles | 23*L* | 5 | 12 | 9 | 17 | 11 | 54 | 216 | 239 | |
| 30 | Rifles, automatic | | | | | | 4 | 4 | 16 | 16 | |

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